Chemical Engineering

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JULY 27, 1959
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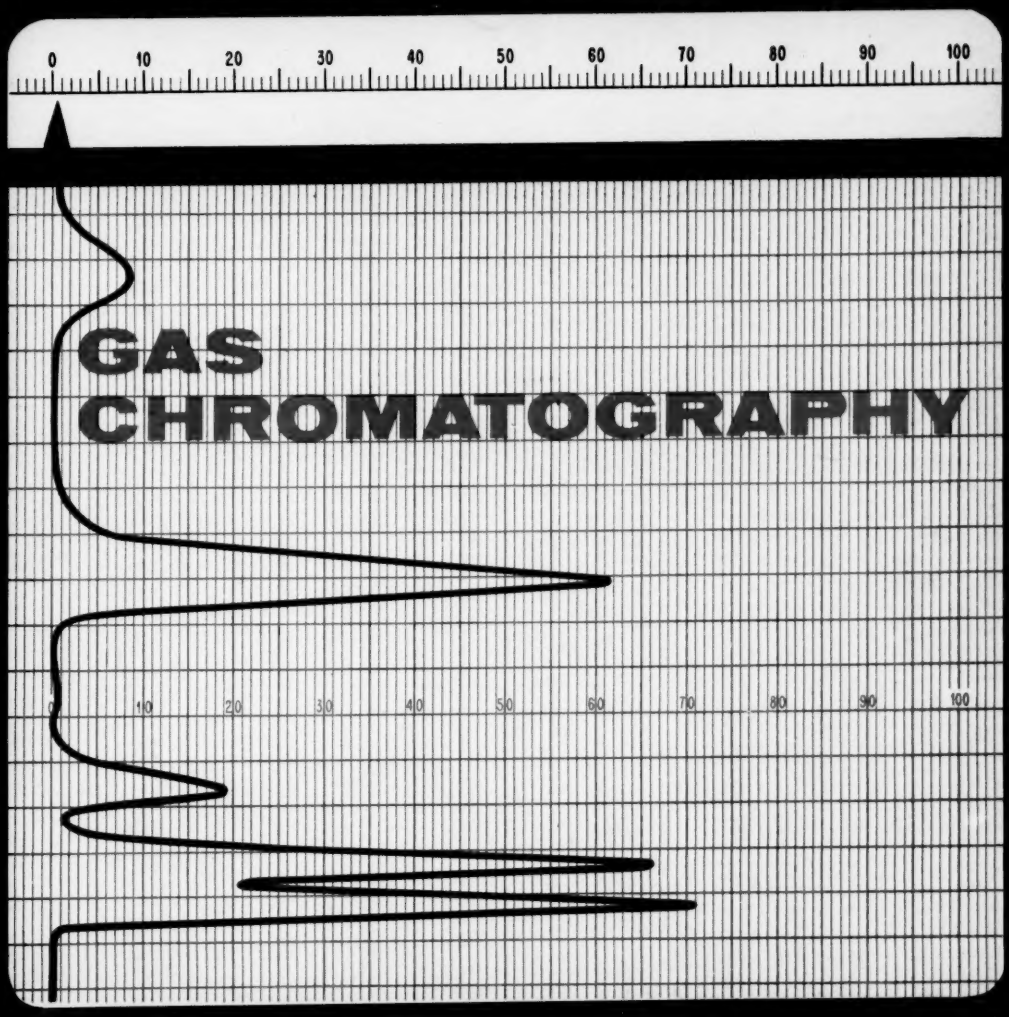
Seventy-five cents



On-Stream Instrumentation News
Make-Believe Heat Exchanger
When you will quit your job

PAGE THREE

EIMCO *design and production*

PROGRESS REPORT

B - 395

Process Engineers, Inc., division of The Eimco Corporation: 420 Peninsular Ave., San Mateo, Calif.

World's Largest Covered Thickeners in Operation At U. S. Borax & Chemical

Four 230 ft. dia. Eimco-Process heavy-duty thickeners have been in operation for over a year at the United States Borax and Chemical Corporation refinery in Boron, California. These totally enclosed and insulated thickeners, largest of their kind in the world, are part of the CCD circuit from which the strong Borax solution goes to crystallization.

The thickener designs, developed in close cooperation with Pacific Coast Borax Division personnel and the engineering constructors, are custom-adaptations of Eimco-Process Type CX mechanisms. The cover of each unit is supported from radial trusses receiving central support from an 8 ft. dia. concrete column with steel shell that also carries the entire weight and torque of the thickener mechanism. The drive-head with split main gear and bearing was designed to the specific requirement of providing easy maintenance access. A special liquid seal was devised to protect the drive unit from tank vapors, as well as to ensure close control of process conditions.

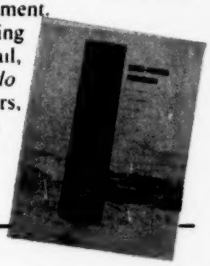
Four totally enclosed Eimco-Process thickeners at Boron, California

Other installation features were the resting of the steel thickener tanks on oiled sand for corrosion prevention; continuous torque recording; and handling the thickener underflows with steam driven reciprocating pumps.

This $20,000,000 processing plant, on an 80 acre desert site, was designed and constructed by Southwestern Engineering Company and Ford J. Twaits Company as a joint venture. It has substantially increased the U. S. Borax capacity and is playing an important part in the production of high energy boron fuels for the space age.

NEW BULLETIN AVAILABLE

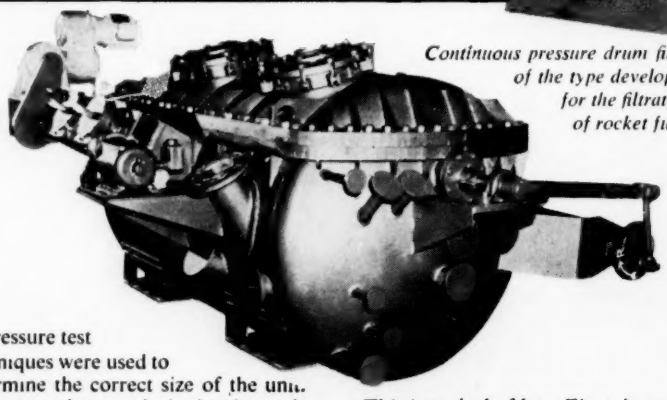
We recently completed an eight page bulletin describing our thickeners, hydroseparators, air-lift agitators, reactor-thickeners, slurry mixers and related equipment. It also covers recent design innovations such as our unique Thixo arms and platform lifting devices, and should be in your reference library even if your immediate plans do not include thickening equipment. A request will bring one by return mail, or, if your plans *do* involve thickeners, our nearest sales engineer will deliver a copy in person.



Eimco Filtration Equipment Plays Important Role in Producing Rocket Fuels

At another plant, producing high energy fuels, engineers were faced with a troublesome filtration problem. They had to filter a fuel having an extremely low slurry viscosity, a high percentage of hydrogen in the gas, and containing a dangerously flammable material.

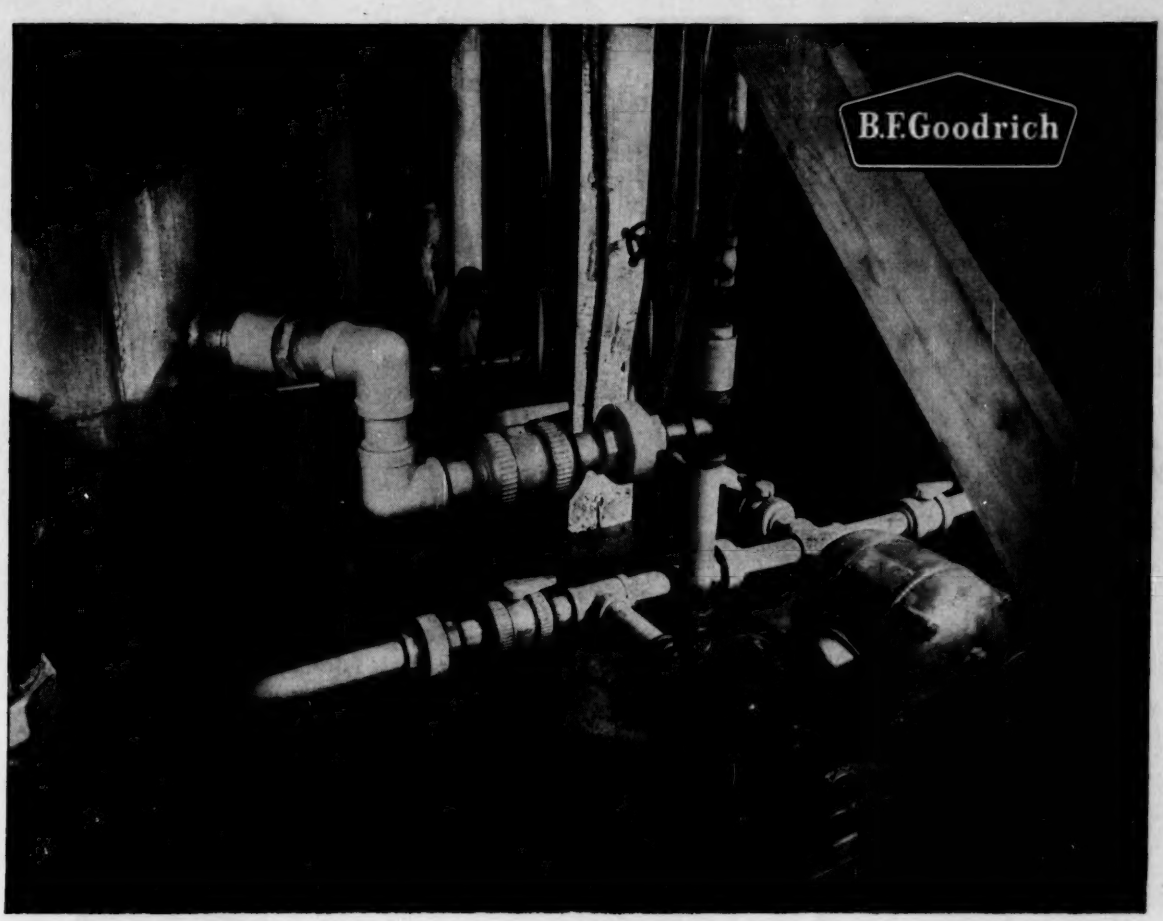
This problem was referred to Eimco's Research and Development center at Palatine, Illinois. Here, the Company's filtration research engineers, after a series of tests, were able to work out special adaptations for a continuous pressure drum filter that met all the specialized application requirements.



Continuous pressure drum filter of the type developed for the filtration of rocket fuels

Pressure test techniques were used to determine the correct size of the unit. Intricate seals were devised to keep air out of the pressure vessel. Changes were made in the hydraulic system. And, the filter was furnished with complete instrumentation.

This is typical of how Eimco's unexcelled research facilities and valuable backlog of experience in engineering custom-designed filter equipment can solve difficult filtration problems.



Fruit juices stay pure flowing through B.F.Goodrich Koroseal PVC pipe

WAYNE PACKING COMPANY, frozen fruit packers, Sodus, New York, expanded early in 1958. Pipe, fittings and valves for new juice handling operations had to meet several requirements . . . (1) resistance to citric acid corrosion; (2) original installation economy; (3) durability, to keep maintenance expense and downtime to a minimum; and (4) most important, they had to be nontoxic to avoid product contamination.

B.F.Goodrich Koroseal PVC pipe and fittings were installed to carry apple, cherry, grape and strawberry juices ranging from single strength to 72 Brix concentrates. Job conditions include temperatures up to 140°F, high humidity, steam vapors and around-the-clock service.

After more than a year's service, Mr. R. S. Chittenden, owner of Wayne Packing, reports, "Koroseal has answered our problems 100%! Not only was this installation economical, but we achieved the durability and sanitation that was so necessary. Our production line runs 24 hours a day, and I'm happy to report not one interruption due to pipe or fitting failure."

In addition to its economy and nontoxic qualities, Koroseal PVC pipe offers superior resistance to corrosion, high impact resistance and excellent insulation properties. It threads easily, can be cut, welded or drilled. It never needs to be painted, will not support combustion. Koroseal is available in pipe, tubes, rods, valves and sheets.

Perhaps Koroseal can solve your problem! *For more detailed information about the advantages of Koroseal, just mail the coupon below.*

B.F.Goodrich Industrial Products Co.
Dept. CE-7, Marietta, Ohio

Please send me free booklets on:

☐ Rigid Koroseal Pipe
☐ Rigid Koroseal Sheet

Name_____

Company_____

City_____ Zone____ State_____

Koroseal—T. M. Reg. U. S. Pat. Off.

B.F.Goodrich *Koroseal rigid PVC products*

LATEST

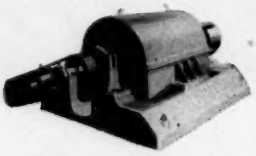
. . . Of The Comprehensive Range Of Equipment Developed For But One Purpose—To Provide The Most Efficient And Economical Method For Handling *Your* Solid-Liquid Separations Whatever The *Materials*, The *Volumes*, The *Process Requirements*

The BIRD-HUMBOLDT / *oscillating screen centrifuge*

Here is a new machine that may save you a lot of money on dewatering of plus 65 mesh granules or crystals. It handles from 5 to 50 or more tons per hour — gets the solids down to 5% or less surface moisture with almost no loss or degradation of solids — operates up to 3000 hours or more without screen replacement — takes only 0.2 KWH per ton of dried solids.

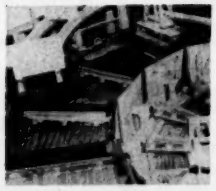
which is the best separating method for you?

That's easy. Just put it up to the Bird Research and Development Center, a fully staffed and equipped pilot-scale testing laboratory devoted exclusively to solid-liquid separation work.

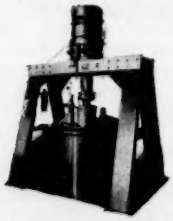


BIRD CONTINUOUS SOLID BOWL CENTRIFUGALS are widely used for a great range of applications. Solids may range from a fraction of a micron to half inch; feed slurries may vary in volume and in consistency; cost of operation and maintenance is seldom more than a few cents per ton.

BIRD-YOUNG ROTARY VACUUM FILTERS offer up to ten times the capacity per foot of filter area of ordinary vacuum filters. Their unique design assures positive, complete discharge of dry cake; ability to handle large volumes of filtrate; multi-stage, countercurrent wash; fume-tight operation.



BIRD-PRAYON HORIZONTAL, PAN TYPE VACUUM FILTERS provide maximum effective cake wash with minimum wash liquor; eliminate cloth blinding troubles; high tonnage per unit of filter area which ranges from 30 to 560 sq. ft.



BIRD SUSPENDED BATCH CENTRIFUGES are for heavy duty, high capacity operation; 40" or 48" basket, perforate or imperforate; fume-tight or explosion proof construction when required.

BIRD MACHINE'S 50th YEAR OF SERVICE TO INDUSTRY

BIRD MACHINE COMPANY

SOUTH WALPOLE, MASSACHUSETTS

Regional Offices:
EVANSTON, ILLINOIS ALAMO, CAL. ATLANTA 9, GEORGIA

BIRD MACHINE'S 50th YEAR OF SERVICE TO INDUSTRY

July 27, 1959 **Chemical Engineering** Vol. 66, No. 15

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

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Contents continued . . . turn page

Here's how to cut Platinum Costs AND IMPROVE PERFORMANCE

...Use General Plate clad metals in the platinum-group

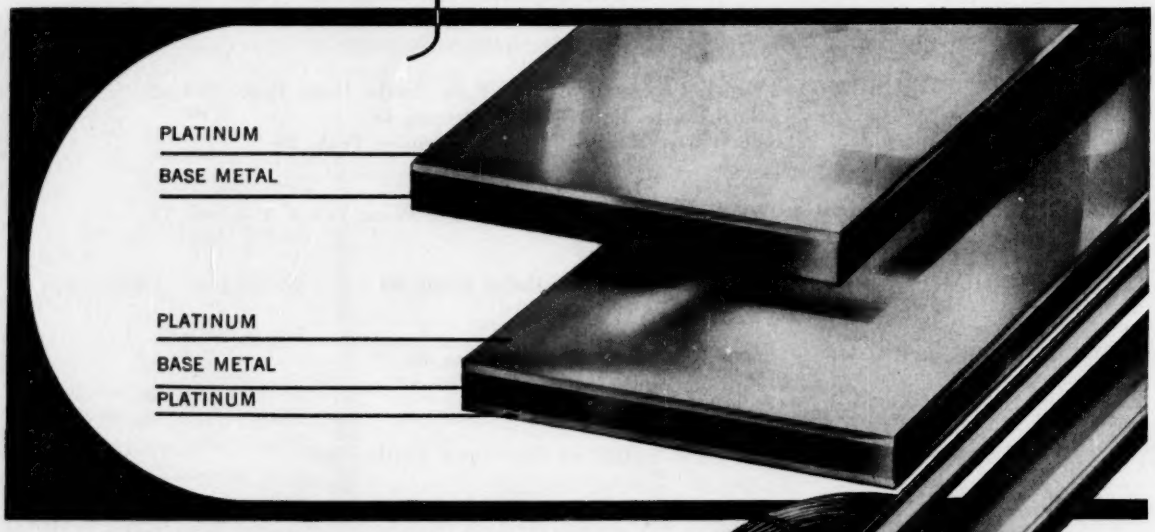
It's possible to get solid platinum performance at a substantial cost saving when you use General Plate Platinum-Group Metals in clad form.

Besides the advantage of greatly reduced cost, General Plate's Clad Metals in the platinum-group provide greater strength, lower weight, higher electrical and thermal conductivity.

Typical applications of General Plate's clad metals in the platinum-group include . . . electrical contacts, slip rings, electrodes, anodes and cathodes, jewelry, rupture discs and laboratory ware.

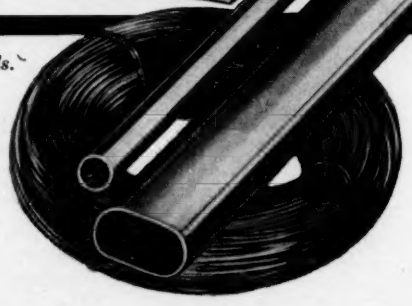
Metals & Controls' new expanded anode of platinum clad tantalum is a good example of how improved performance can be obtained with a real cost saving bonus.

Write for new Technical Data Bulletin PLA-5 which gives information on platinum clad metals.



Other Metals & Controls services and products in platinum-group metals.

- Assaying and refining platinum group metals
- Recovery and rework of spent platinum group materials
- Chemical compounds for catalysts and electroplating solutions
- Alloying platinum-group metals
- Sheets — foil — wire — tubing — gauze
- Thermocouples and thermocouple wire
- Electrical contacts and contact assemblies for switches, relays, instruments, controls and similar applications



You Can Profit By Using General Plate Clad Metals.

METALS & CONTROLS

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A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

General Plate Products: Clad Metals • Electrical Contacts • Truflex® Thermostat Metal
Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals

Chemical Engineering July 27, 1959

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Whether searching for super-smooth sealers.....

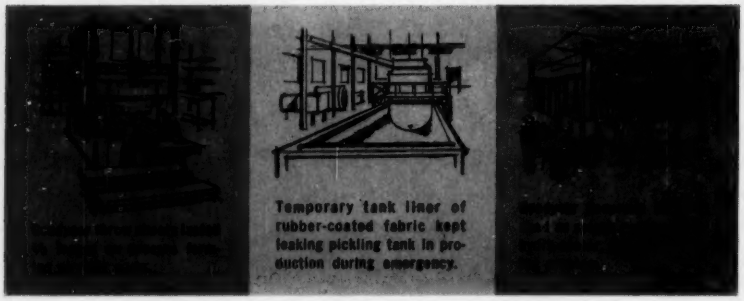
Gaskets as shown magnified 2½ times

You can actually see the advantage of using the new Goodyear packing. The new, amazingly smooth "plate finish"—at no price premium—assures a tighter seal with less sealing pressure. And that's in addition to exceptional resistance to aging and hardening, thanks to the superlative compounding of top-grade rubbers.

...a way to "ground" giant grindstones.....

Six-hundred-pound abrasive wheels drop safely to the floor from a 5-foot height onto a section of steel-backed rubber Armaplate. Heavy rubber sheeting lasted one week on this rugged job; Armaplate over a year.

...or rubber for most any other use.....


Temporary tank liner of rubber-coated fabric kept leaking pickling tank in production during emergency.

And that's only a sample of the unusual problems solved by the G.T.M.—Goodyear Technical Man—and his colleagues with special rubber products.

To turn top rubber experts loose on your problem—even if you've never before thought of rubber as a possible answer—contact the G.T.M. through your Goodyear Distributor—or by writing Goodyear, Industrial Products Division, Akron 16, Ohio.

...you'll find what you need at...

GOODYEAR

THE GREATEST NAME IN RUBBER

Armaplate—T. M.
The Goodyear Tire & Rubber Company, Akron, Ohio

Equipment made with aluminum serves longer with less attention, looks new longer with less protection. Aluminum conductors are much lower in cost than copper conductors with the same current-carrying capacity. Aluminum won't rust, and it resists corrosion. It's the *lowest-cost* corrosion resistant metal.

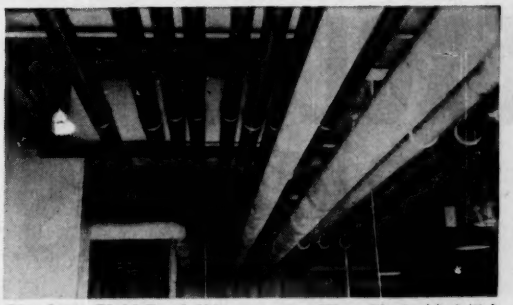
These are the big reasons more and more electrical equipment is made with Reynolds Aluminum —and why this equipment is preferred for chemical processing installations.

And there are other reasons, just as important. Equipment and conductors made with aluminum are easier to handle, easier to install. Aluminum is about one-third the weight of steel, or copper.

Aluminum's electrical properties can improve the performance of your electrical systems, too. Aluminum conductors often carry more current, and have excellent thermal conductivity, as well. Voltage drop may be lower with aluminum, and aluminum is non-magnetic, non-sparking.

For an electrical system or electrical equipment that will perform better, require less maintenance, and cost to install, specify conductors and equipment made with Reynolds Aluminum for the following applications . . . substations (structural members and conductors), wire and cable, cable trays and interlocked armored cable (sheathing and conductor), bus duct systems, bus bar or tube (available silver plated or bare), rigid conduit, metal enclosed switch gear. And you'll find tough, corrosion-resistant Reynolds Aluminum can cut your costs and improve plant appearance in a wide range of chemical and petroleum processing applications: jacketing, heat exchangers, tanks and vessels, piping, even drilling equipment.

Contact your local Reynolds branch office for details, or write *Reynolds Metals Company, P.O. Box 2346-CJ, Richmond 18, Virginia.*



Aluminum Rigid Conduit is now competitive with steel in initial cost, and lower in installed cost. 10 ft. length, 3 in. size, weighs just 27 lbs., compared with 69 lbs. for steel. It's non-magnetic, non-sparking, non-rusting.

Aluminum Structurals are ideal for chemical processing substations. Their light weight cuts installation time, their corrosion-resistance adds years of service.

Interlocked Armor Cables and Cable Trays made with aluminum can be installed much faster than equivalent steel systems. Corrosion-resistant, non-magnetic, as well.

REYNOLDS ALUMINUM

Write today for free brochures on Reynolds Aluminum in electrical applications.

Watch Reynolds TV show **"WALT DISNEY PRESENTS"** every week on **ABC-TV**

Reynolds Metals Company
P.O. Box 2346-CJ, Richmond 18, Virginia

Gentlemen: Please send me the brochures I have checked below.

- ☐ "Reynolds Aluminum in the Electrical Industry"
- ☐ "Aluminum Rigid Conduit"
- ☐ "Silver Plated Bus Bar"
- ☐ "5005 All Aluminum Conductor"

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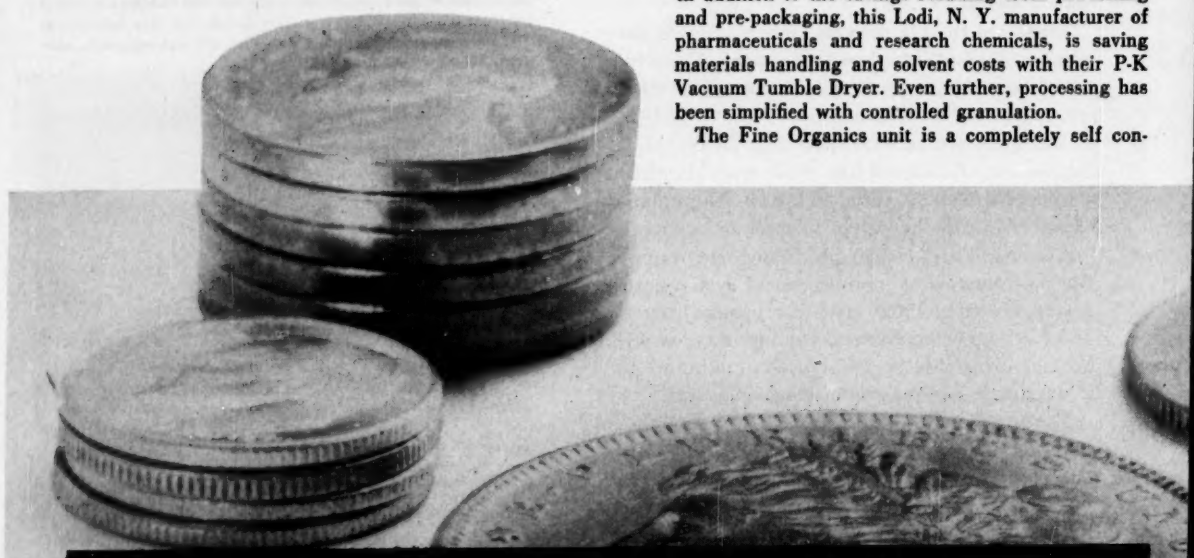
EXCLUSIVE SAVINGS *at Fine Organics Inc.*

In addition to the savings resulting from pre-testing and pre-packaging, this Lodi, N. Y. manufacturer of pharmaceuticals and research chemicals, is saving materials handling and solvent costs with their P-K Vacuum Tumble Dryer. Even further, processing has been simplified with controlled granulation.

The Fine Organics unit is a completely self con-

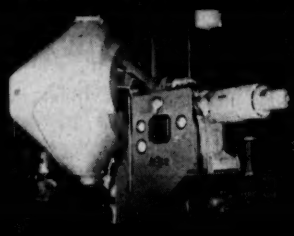


PRE-TESTED!

Full-scale drying in vacuum tumble dryers can be previewed at P-K's Vacuum Tumble Dryer Pre-Test Laboratory. Pre-testing realistically points the way to economies in drying time, solvent recovery, process simplification and handling costs. And it permits modification of controls, condenser, vapor line, receiver and other components to the individual needs of your process and product.

PRE-PACKAGED!

Pre-packaging utilizes P-K's knowledge of companion equipment and parts. Units arrive completely assembled, fully balanced and ready for use. This eliminates costly, time-consuming trial and error during assembly and installation. It saves engineering time and overhead from design through purchasing and start-up. You can even see the difference! A neat compactness makes production areas look better.



EXCLUSIVE COMBINATION!

Only P-K Vacuum Tumble Dryers offer pre-tested, pre-packaged savings. In pre-testing, results are predicted with a detailed procedure report and test samples. In pre-packaging, a single source of responsibility delivers a tailored, thoroughly proved assembly at a cost far less than a do-it-yourself project.

Compared to tray drying, the advantages of P-K Vacuum Tumble Dryers are overwhelming. Drying is many times faster. Expensive solvents are condensed and recovered. And caking that requires separate pulverizing and screening is eliminated. This greatly reduces handling. It often saves enough in labor costs to justify investment. It safeguards against product contamination.

Why not investigate P-K Vacuum Tumble Dryers more completely? We would also welcome an opportunity to tell you about our Liquid-Solids blenders. Our pre-test facilities are at your disposal. Send or bring your test material. For complete information call (Stroudsburg — Hamilton 1-7500) or write George Sweitzer at our East Stroudsburg Headquarters, 1507 Hanson Street. 178

with P-K Vacuum Tumble Dryers

tained 20 cu. ft. dryer shown in the three photos below. It is used to dry chunks of a heat-sensitive waxy compound that contain 20-25% solvent. Open tray-type ovens were formerly used. After drying, the compound was conveyed to a pulverizer for sizing. Solvent was not recovered.

With the P-K Dryer, drying time is now 50% faster. Solvent recovery is 25 to 30 gallons per batch, averaging $30 in savings. This alone is expected to total $3,500 to $4,000 a year. Conveying and separate pulverizing is unnecessary because controlled tumbling action produces the desired pea-size granulation during drying. In other applications, particle size can be reduced to fine powders with a special P-K Intensifier Bar.

pre-test your savings

Patterson Kelley

Chemical and Process Equipment Division

PATTERSON KELLEY CO., INC.
EAST STROUDSBURG, PENNSYLVANIA

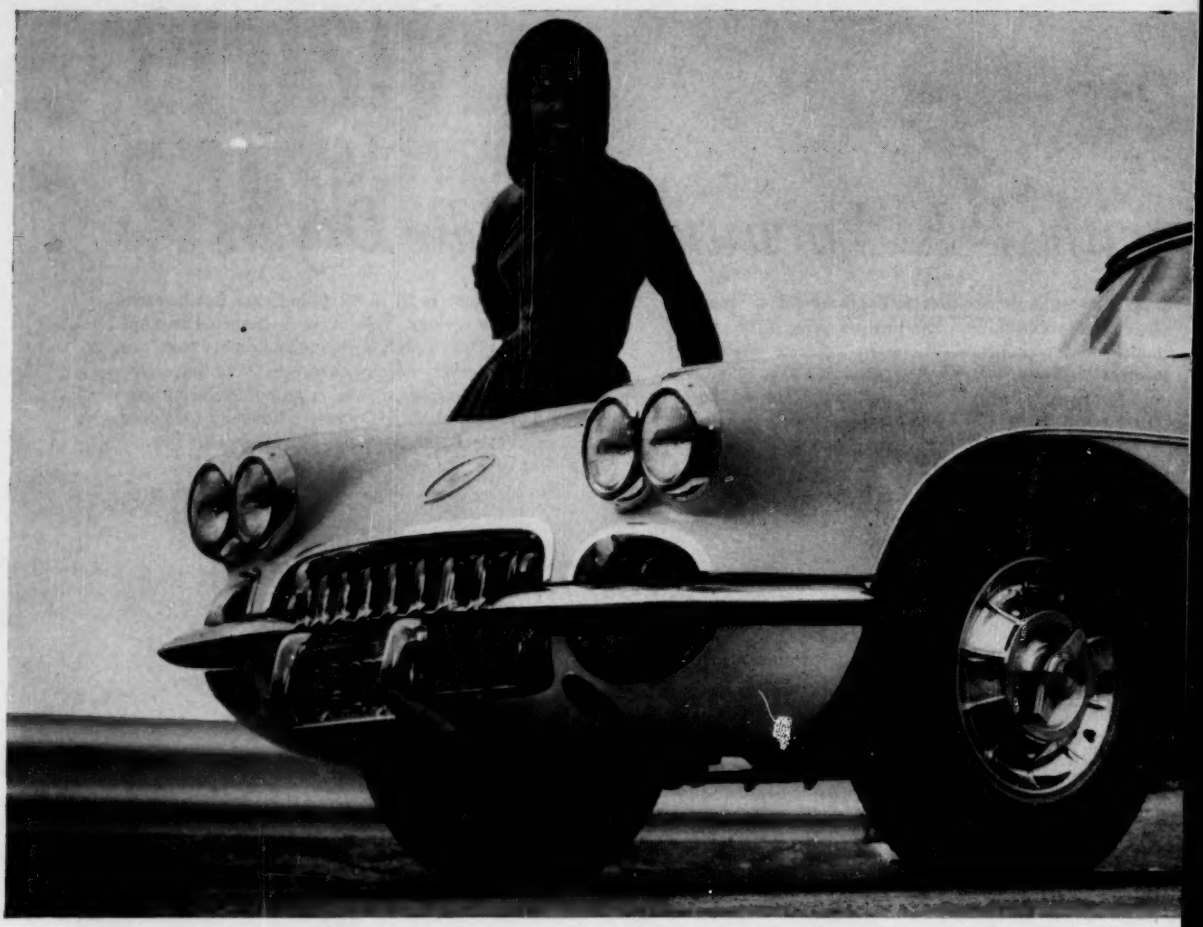
Please send technical literature on P-K Pre-packaged Vacuum Tumble Dryers and details of your offer to pre-test our use of them.

Name_____ Title_____

Company_____

Street_____

City_____ State_____

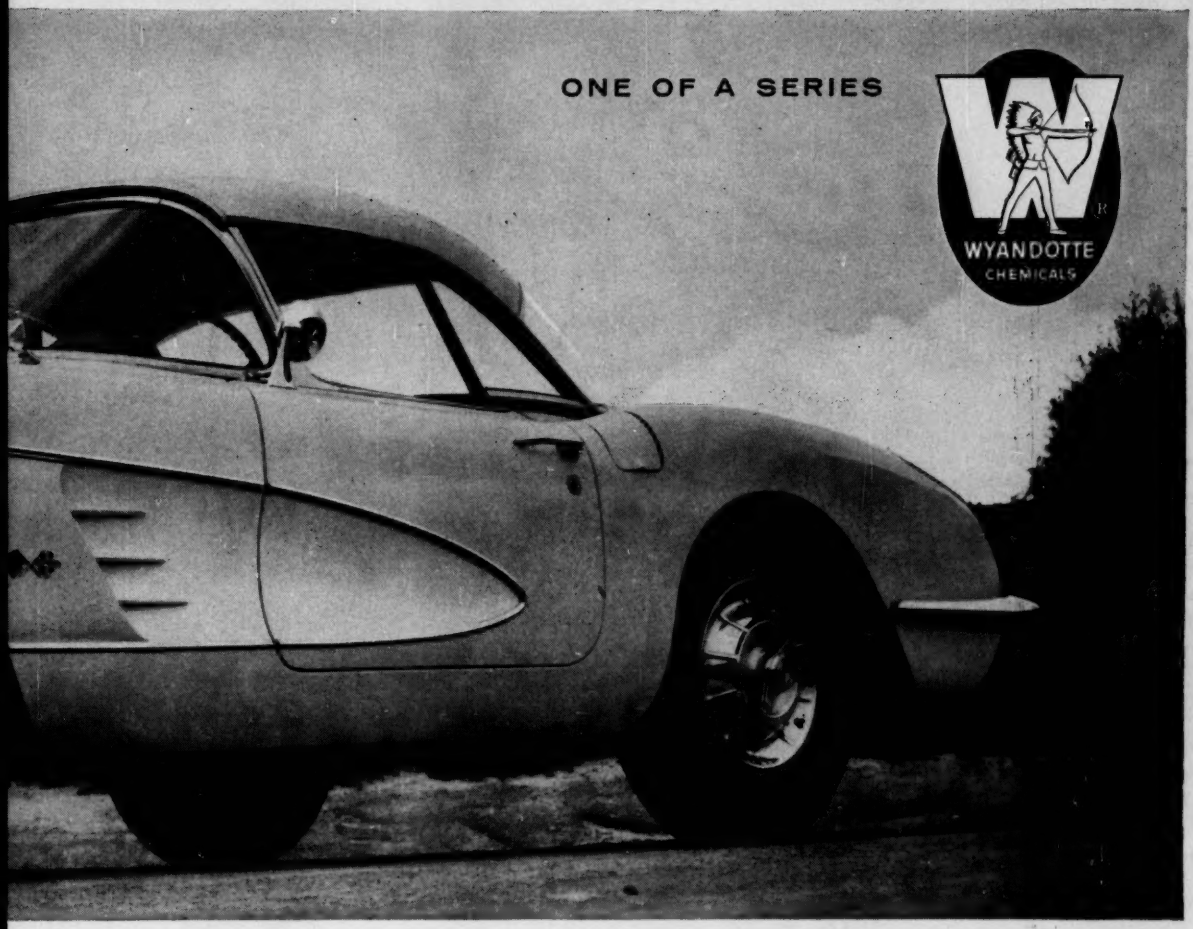


WYANDOTTE PURECAL®
makes countless things better because

PURECAL's extreme purity permits its use as a neutralizing agent in the preparation of lifesaving antibiotics.

Four-color reproduction sparkles brilliantly on printing paper stocks that contain PURECAL in the coating.

Lickin' good and U.S.P. pure . . . even ice cream is better with Wyandotte PURECAL in the formulation.



Trim, smooth, and tough . . . sports car bodies like this beauty are made better with PURECAL. In glass-fiber-reinforced plastics, PURECAL extends polyester resins as much as 50%, reduces shrinkage due to polymerization, provides smoother, harder surfaces.

it's so pure, so white, so uniform

Ten-to-one you can touch plastic right now! Plastics are making a world of better products . . . from the comb in your pocket to the sleek sports car in the nearest parking lot. And Wyandotte PURECAL is playing an important part in the expanding plastics market as a cost-reducing filler for polyester, epoxy and vinyl resins, and glass-fiber-reinforced plastics.

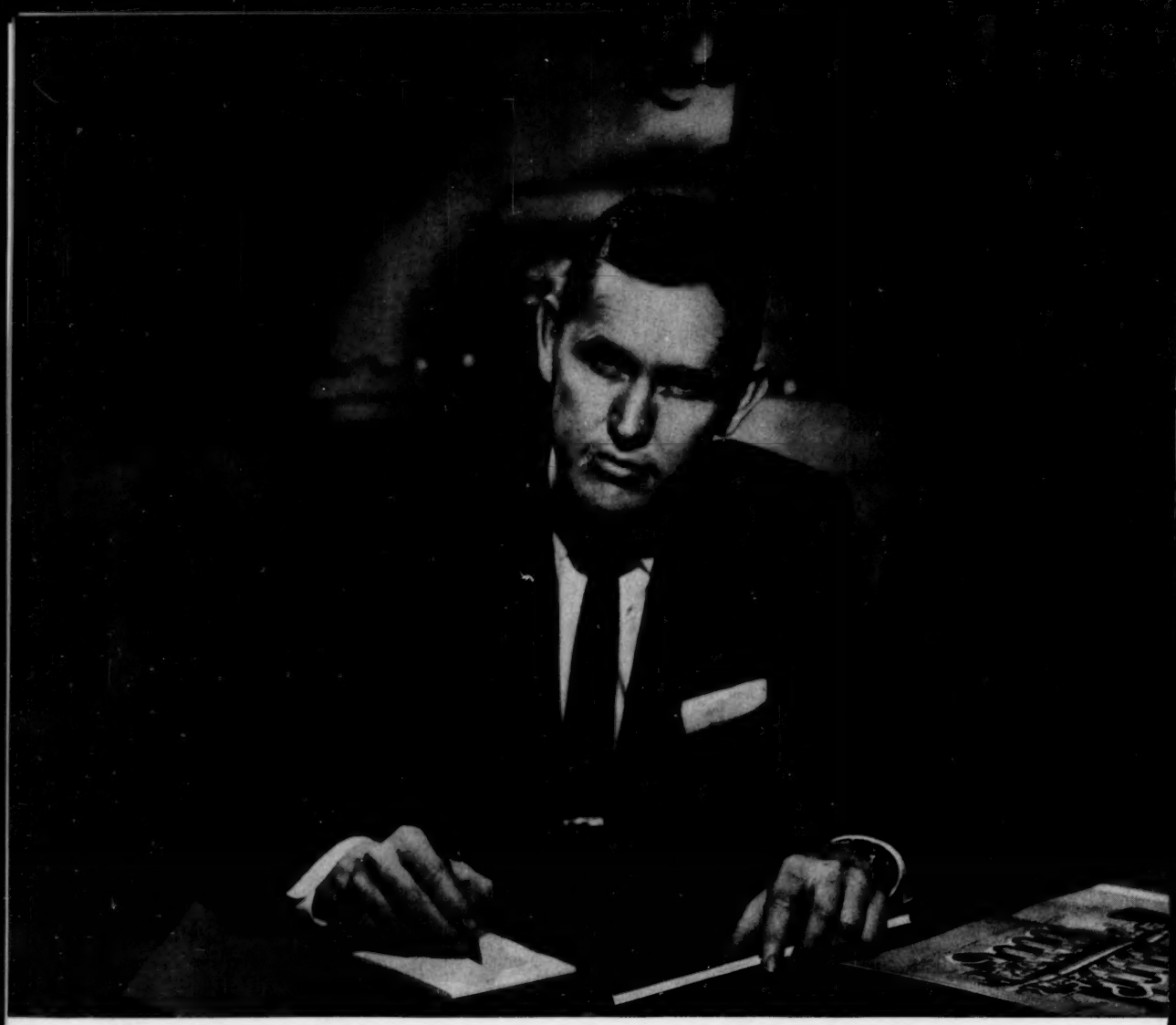
Here's why: Wyandotte's unique double-refining process yields a precipitated calcium carbonate that exceeds U.S.P. purity standards – the whitest material in its class, with cubically shaped particles of accurate size and exceptional uniformity. For these reasons, it is not only an ideal filler for plastics, but makes countless things better, from antacid tablets and antibiotics to printing inks and paint pigments.

If your formulation calls for calcium carbonate . . . it will pay you to write for PURECAL calcium carbonate samples and data today. Various grades are available for specific applications, so please include details on your requirements. *Wyandotte Chemicals Corporation, Department 1-E, Wyandotte, Michigan. Offices in principal cities.*

Wyandotte CHEMICALS MICHIGAN ALKALI DIVISION

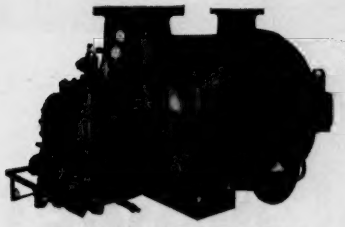
Pacing Progress with Creative Chemistry

SODA ASH • CAUSTIC SODA • BICARBONATE OF SODA • CALCIUM CARBONATE • CALCIUM CHLORIDE • CHLORINE • MURIATIC ACID • HYDROGEN • DRY ICE • GLYCOLS
SYNTHETIC DETERGENTS (anionic and nonionic) • SODIUM CMC • ETHYLENE OXIDE • ETHYLENE DICHLORIDE • POLYETHYLENE GLYCOL • PROPYLENE OXIDE
PROPYLENE DICHLORIDE • POLYPROPYLENE GLYCOL • DICHLORODIMETHYLHYDANTOIN • CHLORINATED SOLVENTS • OTHER ORGANIC AND INORGANIC CHEMICALS

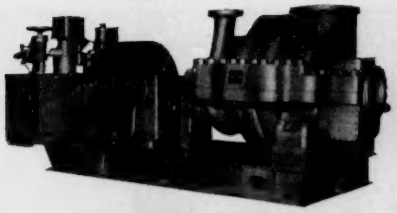


John L. Parris, *Manager Centrifugal Compressor Sales, The Cooper-Bessemer Corporation, explains...*

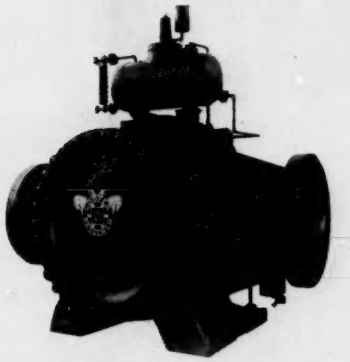
How you gain four ways when you specify Cooper-Bessemer Centrifugal Compressors



Horizontally split, process air or gas centrifugal compressor. Range: Up to 100,000 cfm.



Horizontally split, intercooled centrifugal compressor designed for low cost shop and process air and gas. Up to 30,000 cfm.



Pipeline centrifugal booster with a history of record-breaking performance. Up to 20,000 bhp.

Installations can be integrated with Cooper-Bessemer En-Tronic Controls all the way from simple monitoring to complete system automation.

Barrel type centrifugal compressor for gas and air at pressures up to 5000 psi.

To get the most for your compressor dollars, it will pay you to check into Cooper-Bessemer Centrifugal Compressors because these fully-proved products offer you a combination of four outstanding advantages:

1. You get a design that's matched to your needs. A wide range of types and sizes of Cooper-Bessemer Centrifugal Compressors are available to assure optimum performance on *your* processing or air supply application.

2. You get unsurpassed quality. The designs include many field-proven distinctive features. Cooper-Bessemer's high standards of materials and craftsmanship are applied to every component of these precision-built units... to assure utmost reliability.

3. You can get undivided responsibility. We can engineer the entire compressor installation, including drive and controls. Cooper-Bessemer En-Tronic Controls are available to provide any degree of automation.

4. You get service for most profitable performance. Our outstanding field service and warehouse facilities assure prompt attention to your operating needs... with resulting reduction in your inventory and downtime.

Our nearest office will gladly supply complete information on Cooper-Bessemer Centrifugal Compressors to meet your needs exactly. Call them today.

BRANCH OFFICES: Grove City • New York • Chicago • Washington
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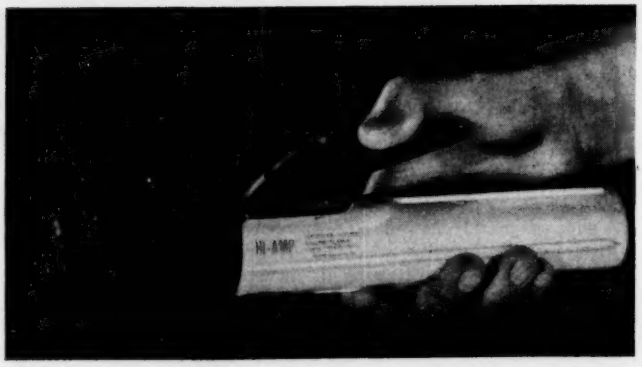
GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL,
ENGINE OR MOTOR DRIVEN

CYANAMID

Chemical Newsfront

DUST AND LINT GET THE BRUSH-OFF from surfaces made from materials treated with CATANAC® SN *Antistatic Agent.* (triangle, left, above.) The outstanding quality of CATANAC SN is its ability to prevent the accumulation of static charge on a wide variety of substances including textiles, plastics, paper, surface coatings, glass and many others. Application is made by spray, brush, wiping, dipping, or, with plastics and resins, by incorporation into the molding composition. Materials containing CATANAC SN will retain their antistatic quality even after soap and water washings. This new antistatic agent is easy to apply and economical. It is ideal for use wherever undesirable static charge is present. **(Market Development Department)**



ELECTRODE HOLDERS ARE COLORFULLY INSULATED with LAMINAC® *polyester pre-mix molding compound.* Lenco Inc., maker of welding accessories, uses LAMINAC pre-mix in electrode holders because of its high impact strength, excellent flame and heat resistance, low moisture absorption, good electrical properties. The colors, red on tips and trigger, yellow on handle, are molded into the glass-filled LAMINAC for instant identification and safety. Lenco molds the parts in low-pressure compression presses, heated to about 350° F. Because LAMINAC has exceptionally good flow, high molding pressures are not needed to achieve sharp reproduction of mold contours. **(Plastics and Resins Division)**

UNIQUE TEST SPEEDS RUBBER'S WAR ON OZONE. Ozone can attack rubber, and cause such damage as cracked tire walls, severely shortening the life of rubber products. Cyanamid has recently developed an effective laboratory procedure for screening organic compounds as potential antiozonants. In this way, scientists can narrow the search through the many organic compounds to help determine which show enough promise to make actual field testing in rubber worth while. The screening method measures the ability of a compound to suppress reaction of ozone with a model unsaturated hydrocarbon. This latest tool in the war on ozone is already hard at work in Cyanamid's program to develop more effective antiozonants. **(Rubber Chemicals Department)**

GREATER DRY STRENGTH FOR PAPER PRODUCTS is being achieved in scores of mills with ACCOSTRENGTH® RESIN 2386. A synthetic, water soluble polymer, ACCOSTRENGTH 2386 is used for either stock addition or surface application to paper and paperboard. Improved dry strength is evidenced by higher tensile strength, greater folding endurance, added bursting strength and increased inter-fiber bonding and wax pick. ACCOSTRENGTH 2386 has unique ability to bring about greater dry strength with little change in bulk or porosity and thus proves highly valuable in the manufacture of printing papers and similar grades. **(Paper Chemicals Department)**

INSECTS DROP LIKE FLIES. Currently, over 100 formulators are using Cyanamid's MALATHION in insecticides. A unique phosphorus-sulfur containing compound, MALATHION harms neither man nor his animal friends. Yet it brings death, swift and sure, to bugs and insect pests by attacking vital nerve centers in their bodies. Malathion-base insecticides are used to protect fruits, vegetables, ornamentals, livestock and household pets. Its low toxicity to man and animals makes it one of the safest insecticides in the market today. **(Agricultural Division)**

CYANAMID

AMERICAN CYANAMID COMPANY
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

For further information on products in this advertisement wire, phone—or mail this coupon to:

AMERICAN CYANAMID COMPANY
30 Rockefeller Plaza, New York 20, N. Y.

Please send me additional information

- ☐ CATANAC® SN Antistatic Agent
- ☐ LAMINAC® polyester pre-mix molding compound
- ☐ ACCOSTRENGTH® RESIN 2386
- ☐ MALATHION
- ☐ ANTIOZONANTS

Name_____

Company_____ Position or Title_____

Address_____

City_____ Zone_____ State_____

Fred Wheelwright, Industrial Sales Manager: "The panels to the right deal with three distinct areas of processing . . . separation of liquids; heat exchange and recovery, and separation of solids. In all three, De Laval equipment offers absolutely top-notch *efficiency* coupled with *high capacity* and *continuous operation*.

"De Laval centrifugal separators are designed for purification or clarification of liquids, or the concentration and recovery of solids from a liquid. De Laval Plate Heat Exchangers are used for product cooling or heating and for the recovery of process heat from sources otherwise going to waste.

The "Syncro-Matic" Separators handle all sorts of solids . . . wet or dry; fine or coarse, heavy or light . . . in all sorts of classification and separation processes. In all of these areas the efficiency of De Laval equipment is unsurpassed; in many areas, it cannot be equaled.

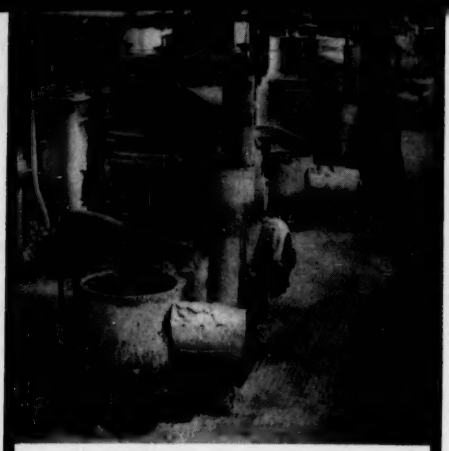
"For more information on these, or any other De Laval products, just mail your request on your letterhead. No obligation, of course."

DEPT. C-7

DE LAVAL

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York
5724 N. Pulaski, Chicago 46, Illinois

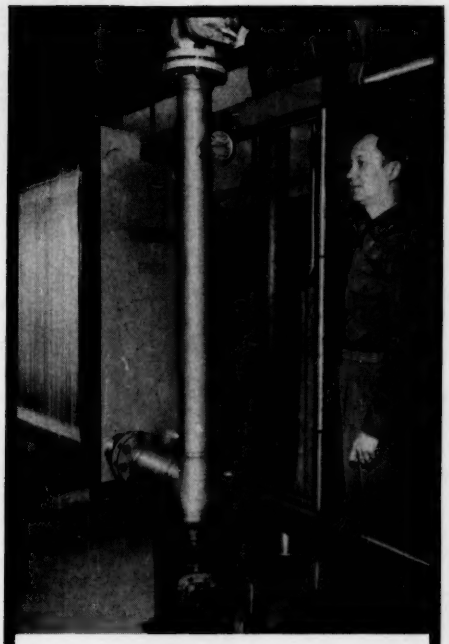
DE LAVAL PACIFIC COMPANY
201 E. Millbrae Avenue, Millbrae, California



CENTRIFUGAL SEPARATORS GIVE YOU CONTINUOUS, HIGH CAPACITY CONCENTRATION OF SOLIDS

De Laval centrifuges bring you continuous, high capacity concentration of solids regardless of the amount, or particle size, of the solids present in a liquid. De Laval offers three types of continuous concentrators. The nozzle bowl (illustrated above as used in the production of Kaolin Clay) works like all our centrifuges, throwing solids to the outer sides of the bowl, except that the solids are discharged *continuously* through nozzles in the bowl wall. In the concentration of coarse or easily packed solids, one of our "Self-Opening" bowls is recommended. They operate similarly to the nozzle bowl, the difference being that solids accumulate to a predetermined level at which point an hydraulic device opens the bowl and the solids are discharged automatically. Both of these machine types can also purify or clarify the liquid phase as part of the same operation. A third type, the conveyor bowl centrifuge is ideally suited to removal of solids from a slurry or suspension, particularly where the mixture is too thick in consistency for practical application of other types. They have been found invaluable where the solids themselves are the desired end-product of the separation. To determine the exact machine for your own particular needs in these (or any other) processing areas, consult De Laval. Complete Pilot Plant and research facilities are at your disposal.

GET MAXIMUM PROCESSING EFFICIENCY WITH DE LAVAL



ABSOLUTE TEMPERATURE CONTROL *PLUS* HEAT RECOVERY EFFICIENCY UP TO 95%

The De Laval Plate Heat Exchanger enables you to maintain as little as 3° temperature differential between your product and the heating or cooling medium. Equipped with De Laval's exclusive Vacuum Steam Heating System, the unit responds *immediately* to changes in operating conditions and will hold to within 1° of preset temperature for as long as you wish. Manufacturers and processors have also found the Plate Heat Exchanger a source of profitable savings, using it to recapture process heat now being wasted and incorporating it into their heating system. However you use it, the unit is always custom-tailored to your exact needs. Its stainless steel plates have multiple benefits: corrosion resistance, easy cleaning, lack of maintenance problems, adaptability, elimination of thermal shock or product burn-on, plus highest heat transfer efficiency.

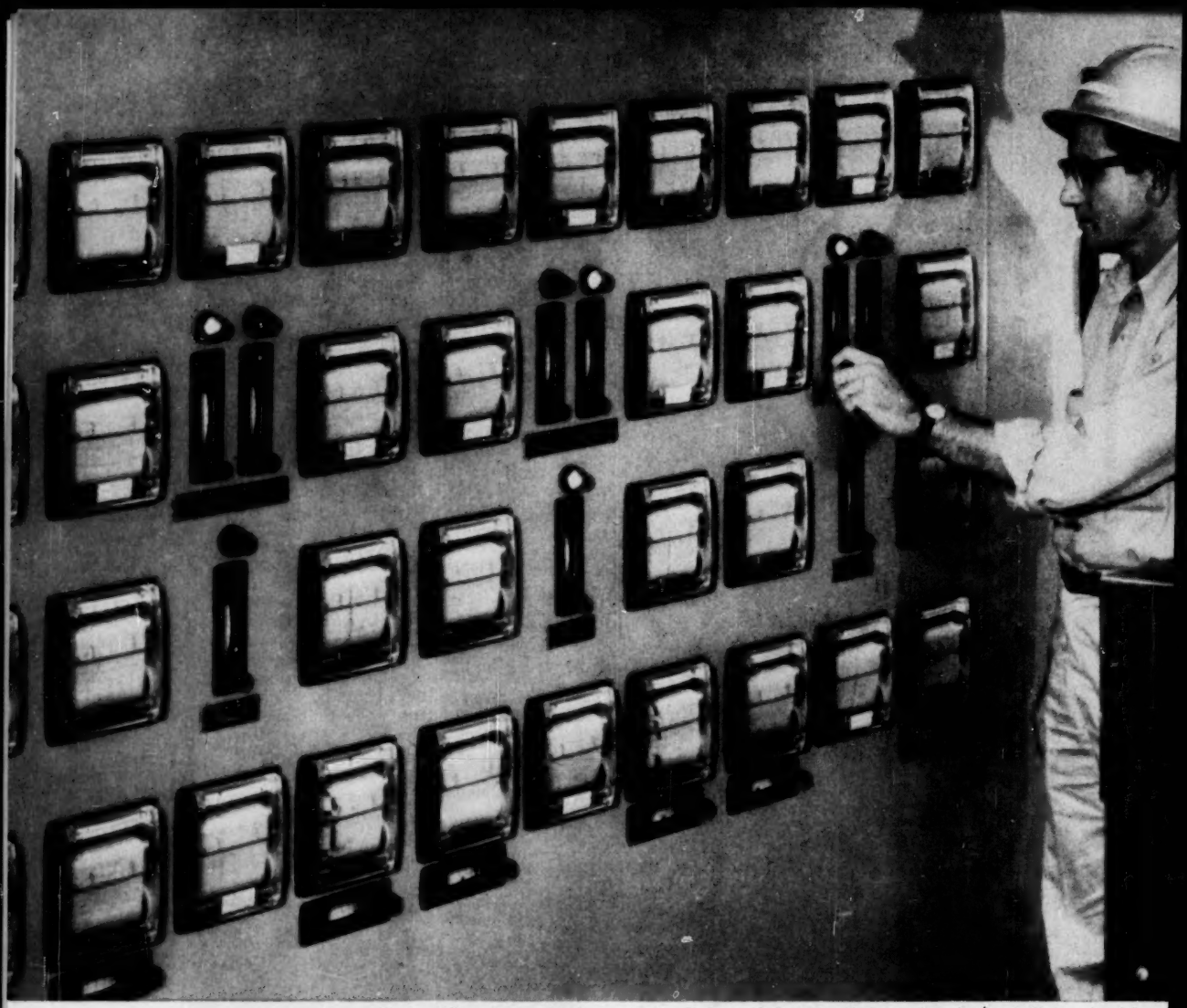
De Laval's Plate Heat Exchanger has found enthusiastic reception throughout the process industries. The illustration shows a unit installed in Chicago at the Petrochemical Department of the Continental Oil Company.

***NOW*...A VIBRATING SCREEN SEPARATOR WITH MOTION CONTROLLED IN ALL THREE DIRECTIONS**

Horizontal, vertical, and gyratory motion are all individually controlled in De Laval's "Syncro-Matic" Separator with TDM (three dimensional motion) Control. It means a tremendous increase in throughput as well as an extraordinary increase in efficiency of separation. Calibrated controls indicate adjustment ranges for frequency and each element of motion. Once the optimum settings for a product have been determined, they can be noted and reset for immediate top efficiency whenever the same product is to be processed again. The action is not affected by a varying feed rate; efficiency is constant whether the machine is set for gentle or turbulent action. The machine is available in carbon or stainless steel with from one to three decks and a full range of screen meshes and materials. It requires no special mounting, and can be easily moved from one location to another. The base of the machine is practically vibrationless, and operation is exceptionally quiet. The "Syncro-Matic" has been successfully applied in chemical, food, mining, and other major industries. It may well be the perfect solution to your own screen separation problems.

PROCESS EQUIPMENT

CENTRIFUGES
PLATE HEAT EXCHANGERS
VIBRATING SCREENS
COMPLETE PROCESSES



Foxboro Consotrol control panel at W. R. Grace & Co. polyethylene plant in Baton Rouge, Louisiana.

Foxboro Consotrols* help put 50 million pound

"Perfect instrument performance on start-up," reports W. R. Grace & Co.'s

50 million pounds of GREX — W. R. Grace & Co.'s new high strength plastic resin — that's the capacity of their new Polymer Chemicals Division plant in Baton Rouge, La. Instrumentation for the 30 acre, multi-million dollar facility was supplied by The Foxboro Company.

"Our main Foxboro panel was a big help in getting this temperature-controlled process off to a successful start," reports instrument supervisor Al Farris. "Over 95% of the variables on the panel are controlled — many of the key ones are part of cascade control systems. Instrument performance on start-up was perfect."

Grace instrument men like their Foxboro pneumatic Consotrols for other reasons as well: The M/54 Recorder's 4-inch vertical-travel chart . . . the drawer-type pull-out feature of Consotrols . . . the fact that in 18 months of operation not a single Consotrol has needed re-calibration.

Foxboro Consotrol instrumentation includes con-

*Reg. U.S. Pat. Off.

Foxboro urges you to attend the I.S.A. Show in Chicago, Sept. 21-25

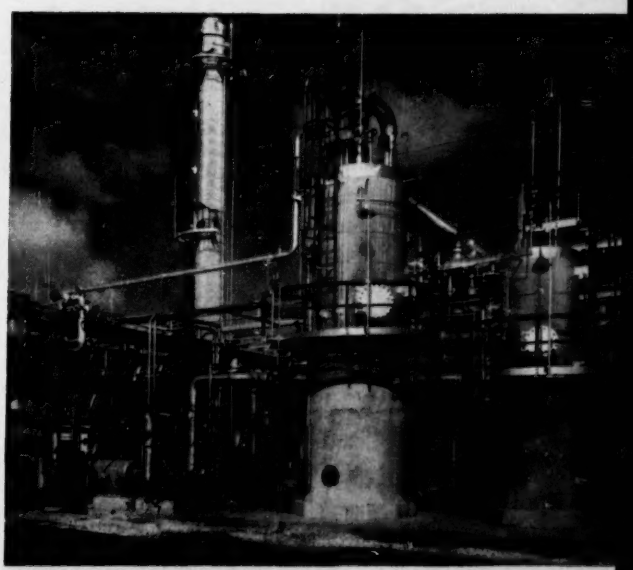
polyethylene plant on stream without a hitch

Polymer Chemicals Division

trol functions for all types of processing requirements — auto-selector . . . cascade and ratio systems . . . automatic batch control. Get the complete story by writing for Bulletin 13-18. **The Foxboro Company, 367 Neponset Ave., Foxboro, Mass.**

FOXBORO

REG. U.S. PAT. OFF.

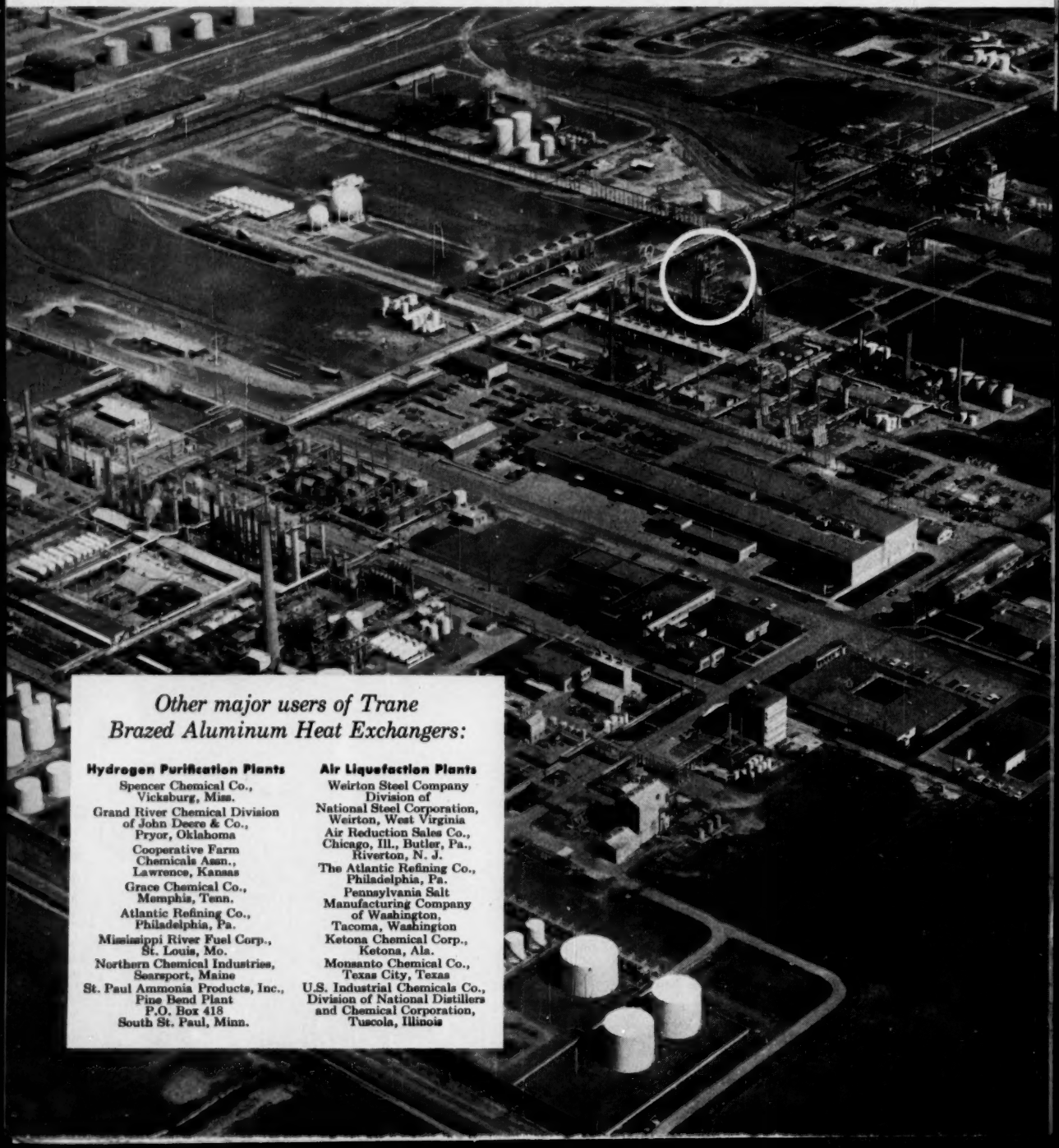


30-acre W. R. Grace & Co. Polymer Chemicals Division plant has 50 million pound annual capacity. First product — new high strength plastic resin tradenamed GREX.

Shell Chemical Corporation reports:

Lower structural, installation
Trane Brazed Aluminum

Air view of Shell Chemical Corporation's Houston, Texas, plant. Lightweight and compact construction of TRANE Brazed Aluminum Heat Exchangers made it possible to install condensing unit on top of a 140-foot tower—cutting construction costs.



Other major users of Trane Brazed Aluminum Heat Exchangers:

Hydrogen Purification Plants

Spencer Chemical Co., Vicksburg, Miss.

Grand River Chemical Division of John Deere & Co., Pryor, Oklahoma

Cooperative Farm Chemicals Assn., Lawrence, Kansas

Grace Chemical Co., Memphis, Tenn.

Atlantic Refining Co., Philadelphia, Pa.

Mississippi River Fuel Corp., St. Louis, Mo.

Northern Chemical Industries, Searsport, Maine

St. Paul Ammonia Products, Inc., Pine Bend Plant P.O. Box 418 South St. Paul, Minn.

Air Liquefaction Plants

Weirton Steel Company Division of National Steel Corporation, Weirton, West Virginia

Air Reduction Sales Co., Chicago, Ill., Butler, Pa., Riverton, N. J.

The Atlantic Refining Co., Philadelphia, Pa.

Pennsylvania Salt Manufacturing Company of Washington, Tacoma, Washington

Ketona Chemical Corp., Ketona, Ala.

Monsanto Chemical Co., Texas City, Texas

U.S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation, Tuscola, Illinois

and piping costs with Heat Exchangers!

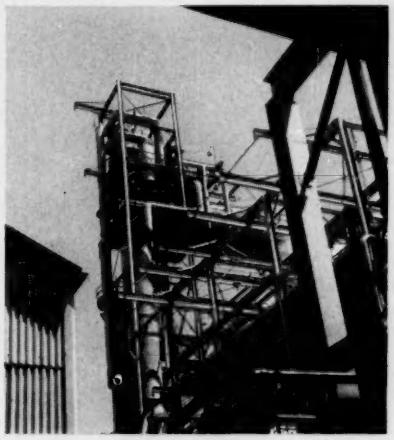
Lightweight aluminum surface made it possible to install heat exchanger on top of 140-foot tower

This Shell Chemical Corporation plant near Houston, Texas, has used TRANE Heat Exchange equipment for over two years in the production of ethylene. And, Shell reports, the TRANE Heat Exchanger is functioning exactly as specified . . . operating at temperatures down to -185° F, with extremely close temperature approaches.

An outstanding feature of the installation is the location of the unit: it was erected on top of a 140-foot tower to reduce piping costs and to meet thermodynamic specifications. This type of installation was possible because of the very lightweight and compact construction of the TRANE Heat Exchanger. And it resulted in lower installation costs, savings in valuable ground space. Shell is achieving lower operating costs, too, because of lower heat losses and extremely close temperature approaches.

This light and compact—yet rugged—heat exchange surface is being used in more and more installations where superior performance is essential. And TRANE Brazed Aluminum Heat Exchangers reduce erection and space costs, too, because a typical TRANE unit requires only *half as much space* as conventional heat transfer equipment!

If you're interested in reduced refrigeration costs, close temperature approaches, trouble-free operation, design with TRANE Brazed Aluminum Heat Exchangers. Thirty years of specialized heat transfer experience is at your service! Ask your nearby TRANE Sales Office for complete information. Or write TRANE, La Crosse, Wisconsin.



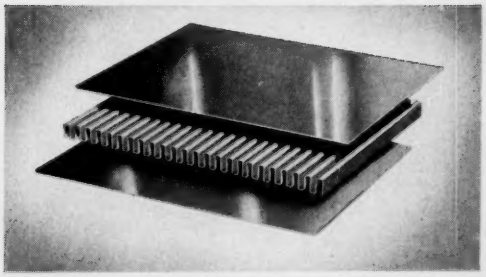
3-stream exchanger condenses a hydrocarbon gas mixture by refrigeration from two colder gases. Operating temperatures are as low as -185° F. Design pressure is *545 psig.*

For any air condition, turn to

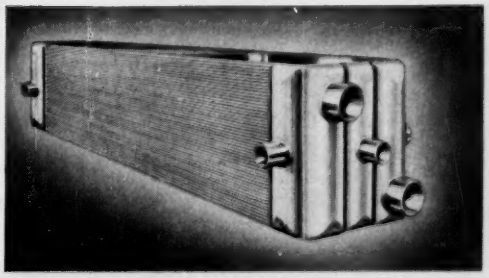
TRANE

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

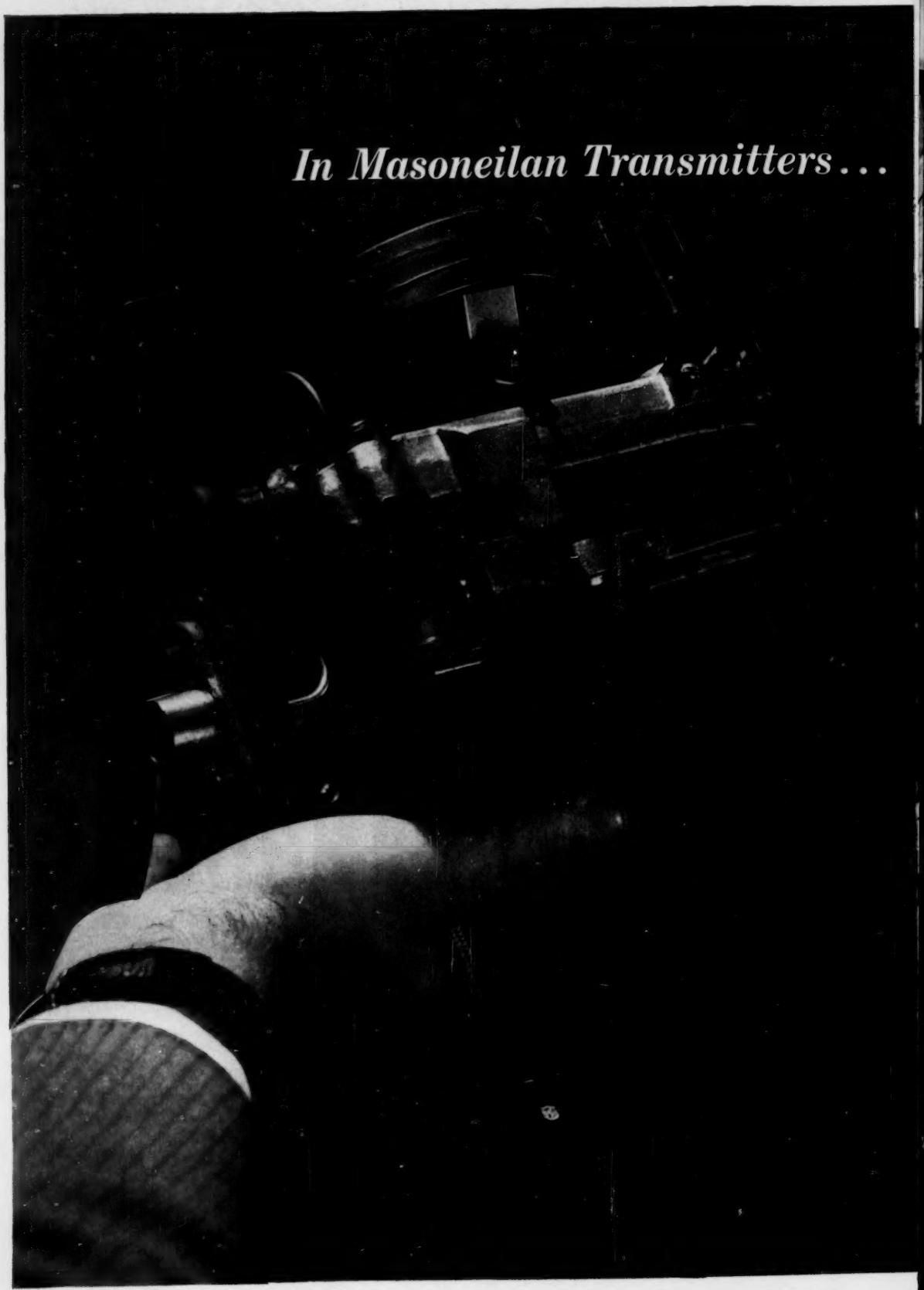
THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 100 U. S. AND 19 CANADIAN OFFICES



Lightweight, compact, rugged! TRANE Brazed Aluminum surface consists of corrugated aluminum sheets brazed together to form a stack of layers that provide individual passages for the flow of gases or liquids. Provides up to *nine times* the surface per square foot of shell-and-tube exchangers!



Headered for 5-stream operation, this TRANE Brazed Aluminum Heat Exchanger can handle as many as five fluids simultaneously. Units are available for either cross-flow or counter-flow operation. Surface can be fabricated in a wide variety of shapes and sizes to meet all types of specifications.


In Masoneilan Transmitters...

Important Design Features Give You Top Performance

Accurate, dependable pneumatic transmission of pressure or temperature is assured by these compact, lightweight, force-balance transmitters. In addition to the advantages inherent in this class of instruments, the Masoneilan design offers a number of features which make them outstanding.

1. Balanced beam permits mounting in any position without zero shift; permits changing position at will without rezeroing.
2. High accuracy — for example a 100F span temperature transmitter set for 0-100F is accurate within ±0.5°.
3. Locked span-location setting is unaffected by vibration — will not shift.
4. High capacity, balanced relay speeds transmission; permits longer transmission lines.
5. Derivative unit and integral receiver gauge may be added without tubing and without removing cover.
6. Unit subassembly construction permits changeover from temperature to pressure (or vice versa), or change of span, without disturbing beam.

Simplicity and unit construction, plus compact ruggedness, make these transmitters very easy to install and maintain. This, plus moderate first cost, makes them a topnotch investment in improved measurement and control. Send for your copy of bulletin.

MASON-NEILAN

A Division of Worthington Corporation
67 NAHATAN STREET, NORWOOD, MASSACHUSETTS
District offices or Distributors in principal cities in U.S.
In Canada: Mason-Neilan, Division of Worthington (Canada), Ltd.

MN9-9

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MN9-9

BREAKTHROUGH

in oxygen compressor design!

ELLIOTT'S NEW CONCEPT

—eliminates previous hazards
—offers substantial savings

New standards of safety and economy are established by this new Elliott oxygen compressor, designed for low flow at high head (high pressure ratio). Compressor and turbine bearings are made of aluminum oxide and are water lubricated, thus eliminating entirely the danger of explosion caused by lubricating oil contamination.

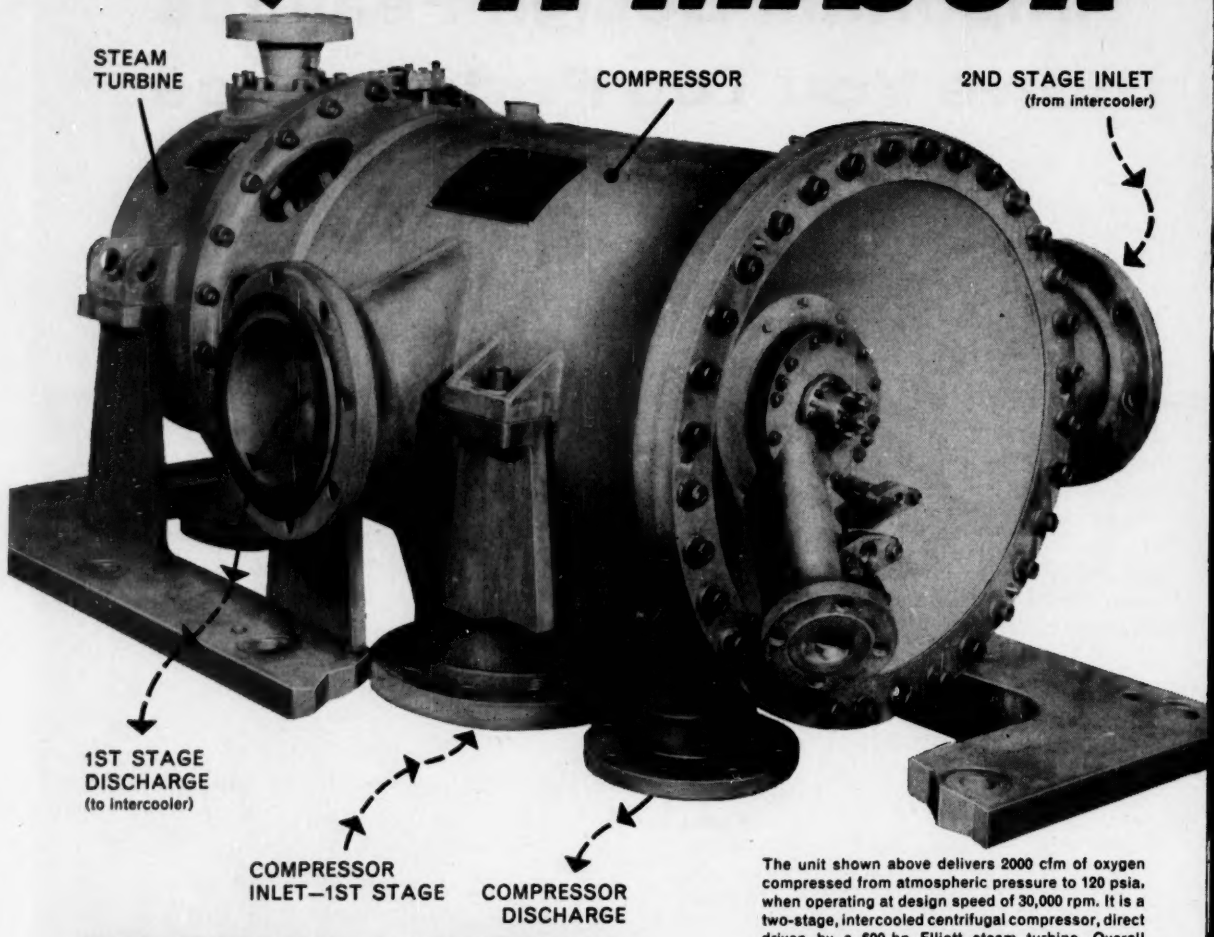
The perfection of water-lubricated "ceramic" bearings is the culmination of long research and development by Elliott engineers. Their achievement eliminates the need for elaborate and complex seals. This new concept in compressor design marks a distinct forward step in safety, efficiency and reliability.

Elliott compressor specialists will be glad to give you complete details of this new line of compressors. Call the nearest Elliott office, or Compressor Department, Elliott Company, Jeannette, Pennsylvania.

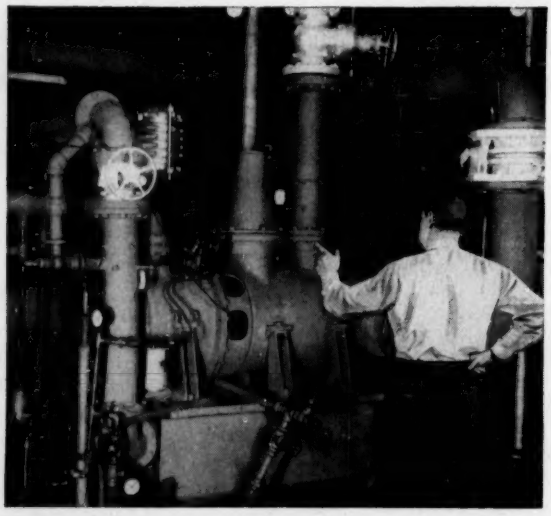
SAFE! Completely water lubricated, no risk of explosion from lube oil contamination. Casings

SIMPLE! No reciprocating parts, no packings to wear, no complex seals. The only moving part

A MAJOR



The unit shown above delivers 2000 cfm of oxygen compressed from atmospheric pressure to 120 psia, when operating at design speed of 30,000 rpm. It is a two-stage, intercooled centrifugal compressor, direct driven by a 600-hp Elliott steam turbine. Overall length, about 36 inches. Other designs and pressures are available. Geared electric motor drive optional.



Turbine-driven centrifugal oxygen compressor during factory test. First unit was subjected to 177 hours of rigorous test, 117 of these at design speed (30,000 rpm) or higher. After 108 starts and stops, no measurable wear could be detected on any bearing. This testing also includes complete tests of direct-connected steam turbine, governed by an electro-pneumatic governor requiring no outside power source.

ELLIOTT Company

JEANNETTE, PENNSYLVANIA

BREAKTHROUGH

in oxygen compressor design!

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—offers substantial savings

New standards of safety and economy are established by this new Elliott oxygen compressor, designed for low flow at high head (high pressure ratio). Compressor and turbine bearings are made of aluminum oxide and are water lubricated, thus eliminating entirely the danger of explosion caused by lubricating oil contamination.

The perfection of water-lubricated "ceramic" bearings is the culmination of long research and development by Elliott engineers. Their achievement eliminates the need for elaborate and complex seals. This new concept in compressor design marks a distinct forward step in safety, efficiency and reliability.

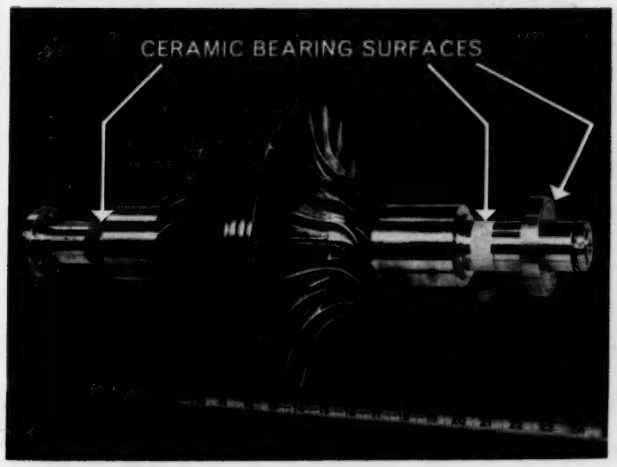
Elliott compressor specialists will be glad to give you complete details of this new line of compressors. Call the nearest Elliott office, or Compressor Department, Elliott Company, Jeannette, Pennsylvania.

SAFE! Completely water lubricated, no risk of explosion from lube oil contamination. Casings are fabricated from stainless steels, which will not burn in an oxygen atmosphere. Another safety feature is the new highly-accurate mechanical overspeed trip for turbine drive.

SPACE SAVING! Occupies but a fraction of the space of equivalent reciprocating equipment. Light in weight, this compact unit requires only simple and inexpensive foundation.

RELIABLE! Elliott's centrifugal compressor experience extends back to the early years of this century. Elliott turbochargers (essentially air compressors), introduced in 1940, serve over 16,000,000 hp of diesel engines. Many of these units operate at speeds exceeding 40,000 rpm. No manufacturer can offer a broader background in centrifugal compressors.

SIMPLE! No reciprocating parts, no packings to wear, no complex seals. The only moving part is the rotor, shown below. The Elliott compressor offers the simplicity and ease of maintenance possible only with a rotating machine. And water-lubrication greatly simplifies the lubrication system.



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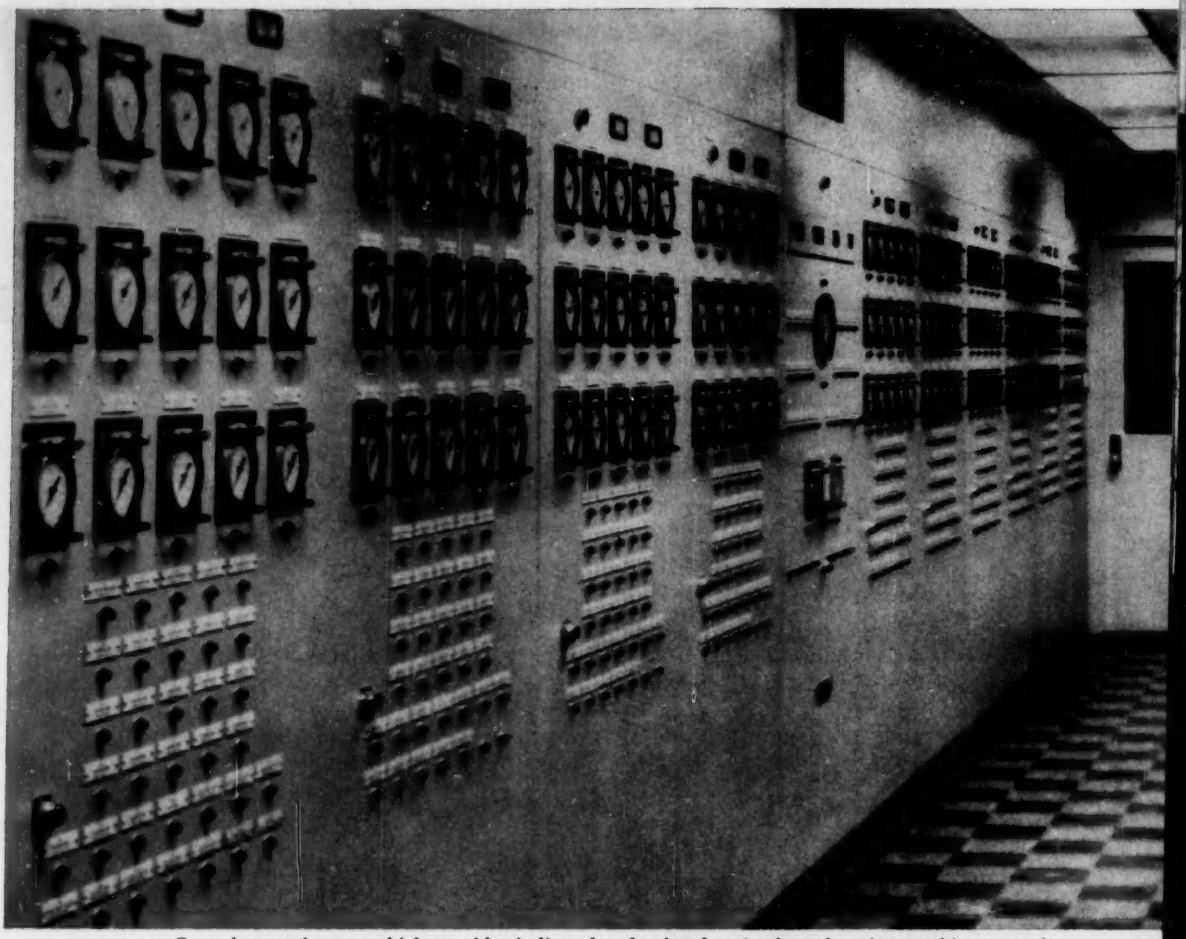
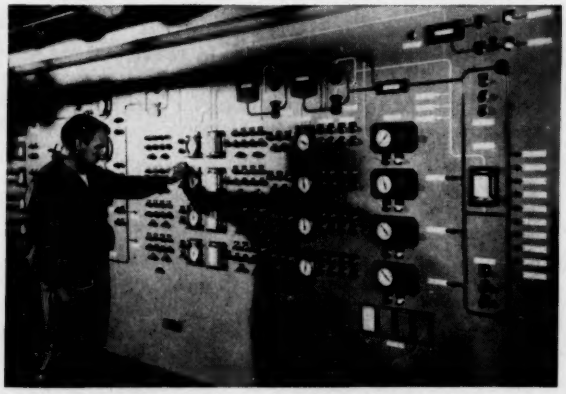


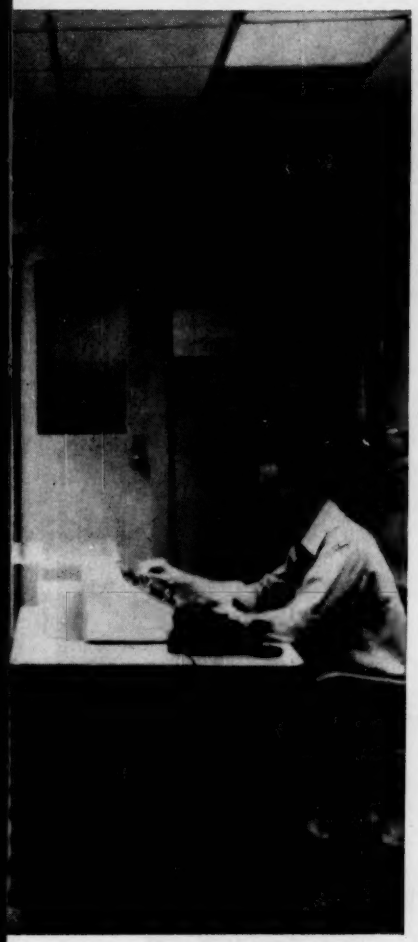
Central control room which provides indicated and printed evaluation of casting machine operations by means of Talyor TRANS-SCAN-LOG system. Typewriters under plastic covers behind operator.

Taylor FULSCOPE* Controllers maintain correct temperature in the wet churns. They receive signals from TRANSAIRE* Transmitters equipped with flat bulbs installed flush with the inside of the churn walls.



One man oversees the viscose filtration and deaeration process from this master Graphic Panel. Taylor miniature indicating and recording instruments enable the operator to quickly pinpoint any abnormal conditions.

Taylor Instruments



Men, machines and Taylor Instruments join forces to produce superior AVISCO cellophane

American Viscose Corporation selected Taylor to furnish the bulk of the instrumentation for the new cellophane plant at Marcus Hook for two main reasons—Taylor's close association with the cellulose industry, and confidence on the part of American Viscose in Taylor Instrument Companies and its products developed over many years.

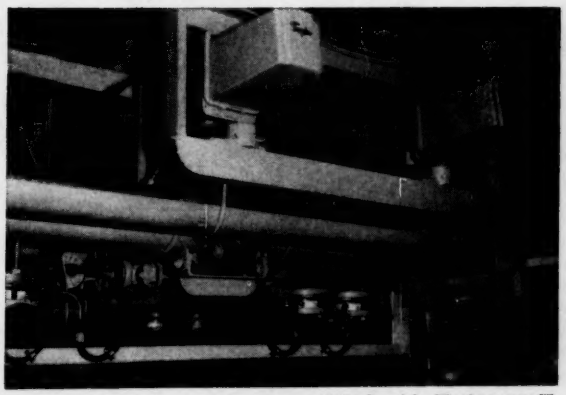
Designed for a capacity of 50,000,000 lbs. of cellophane per year, this plant is among the most modern of its type in the world. Wherever practicable, continuous processing has taken the place of batch operations, necessitating extensive use of automatic control of important process variables at almost every stage.

Photograph at left shows the control center for the important casting area—the largest and most precise control system of its type in any industrial plant, outside of the atomic energy field. Here the Taylor TRANS-SCAN-LOG* system enables one operator to monitor and supervise the overall operation of this stage of the process. Signal lights show at a glance abnormal conditions anywhere in the process. At hourly intervals—or on demand—a typewritten record of all variables is automatically prepared (typewriters shown behind operator). In addition, the operator may select a specific variable, or group of variables, for reading at any time. This system permits operation within closer tolerances than could possibly be obtained with conventional instrumentation.

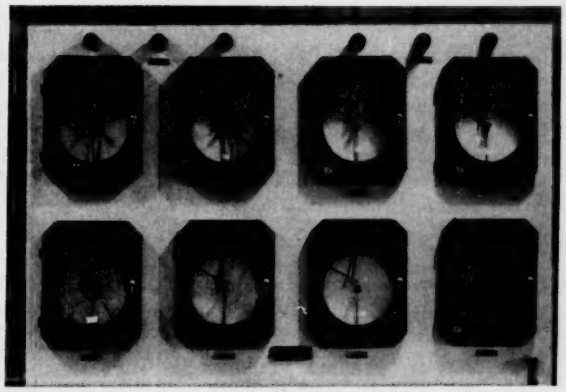
The result, American Viscose tells us, is better, more continuous production and higher quality product.

A Taylor control system may be the answer to your product quality problems—and cut your operating costs too. Why not call in your Taylor Field Engineer, or write Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ontario.

*Reg. U.S. Pat. Off.



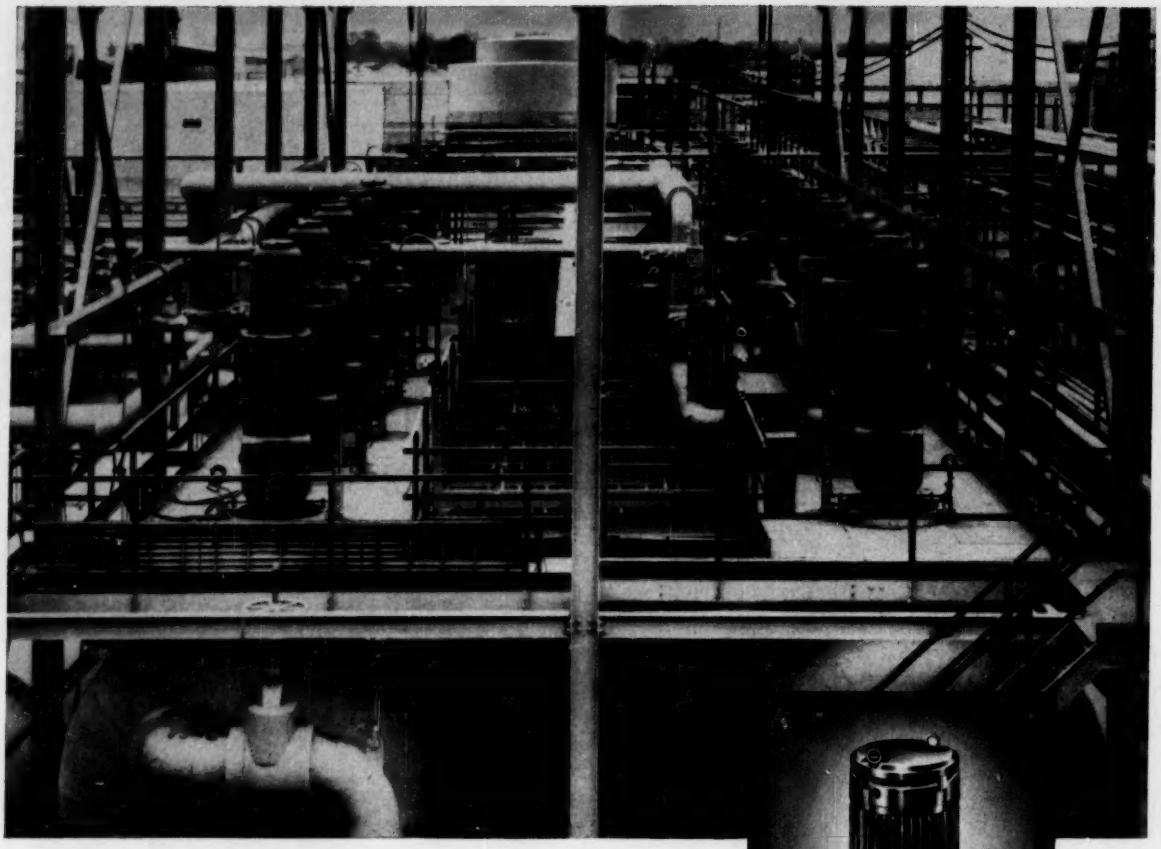
Acid flow measurement is accomplished with Taylor 205T Volumetric DP Transmitters, connected to the process by filled capillary systems and diaphragm seals of Hastelloy. Signal is transmitted to the data logging system.

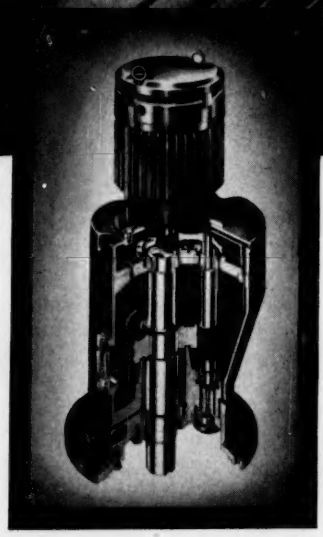


Master control panel for one of the coating towers. Instruments regulate supply of lacquer to the coater, flow and pressure of air for drying, and temperature and humidity conditions within the tower.

VISION • INGENUITY • DEPENDABILITY

MEAN ACCURACY FIRST





50 HP Philadelphia Mixers in continuous operation...

PROOF OF BETTER SHAFT SEALING.

Each of the forty-two Philadelphia Mixers in this pressure vessel mixing operation can produce 99,000 pound-inches of torque for continuous operation under difficult loading conditions . . . the kind of job where anything less than the best agitator shaft operation is an invitation to mechanical seal problems. *Significance:* Philadelphia Mixers have two important advantages over *all* other fluid mixers which assure best output shaft performance in difficult operations.

FIRST. In any comparative evaluation of mixers having equivalent torque capacity, a Philadelphia Mixer will *always* have the largest, heaviest duty, highest capacity bearings . . . and the drive with the best bearing support for shafting will have the truest running shaft.

SECOND. Because the bearings in Philadelphia Mixers are larger, the diameter of the output shaft is larger . . . and the design which has the largest diameter shaft will have least shaft deflection from hydraulic loads imposed on the mixing impeller during operation.

THESE ADVANTAGES come at no cost premium . . . you just get more mixer for your money. Six standard models, 1 to 200 HP. Special units to 500 HP. Horizontal or vertical motor drive. Mechanical seal or packed stuffing box. Paddle or turbine type impellers. Write for catalog A-19.

philadelphia mixers

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INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

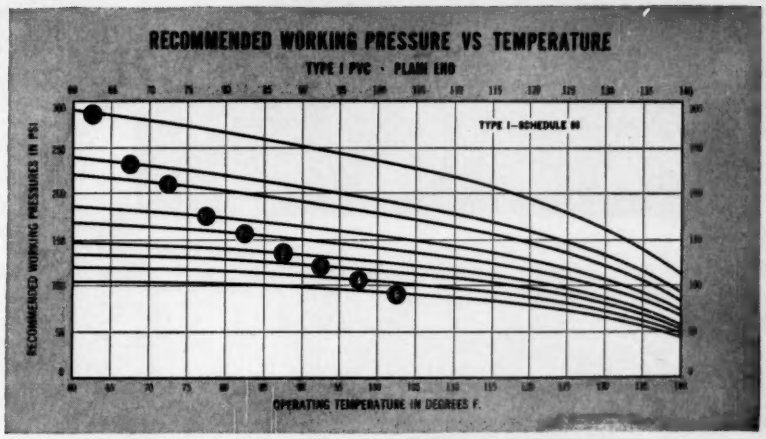
Now you can predict service life because Byers PVC Pipe Engineering brings a factual approach to piping system design

FACT: Extensive testing program is basis for working pressure recommendations

Laboratory and field experience have shown that it is absolutely essential to test the extruded pipe to determine its physical properties.

So, Byers PVC Pipe undergoes continuous testing. Various test methods are used to determine effective tensile, and the lifetime of Byers PVC Pipe under certain pressure-temperature conditions. We give particular emphasis to long term tests. And the test specimens are our own extruded pipe.

Our recommended pressures are usually about 10% of burst pressure rather than the frequently recommended 20%. Safely below the creep range, our values are dependable. That's why you should consider Byers PVC Pipe—Type I or Type II—for your plant services. Call our field service representative for the entire PVC story. **A. M. Byers Company, Clark Building, Pittsburgh 22, Pa.**



To convert our test results into good design practice, you must consider static test loads vs. installed dynamic loads—the experimental variation and the indeterminate loads of actual operation.

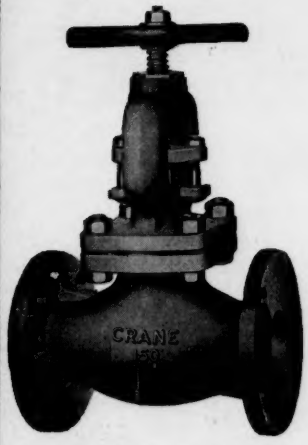
BYERS PVC PIPE

ALSO SHEET AND ROD STOCK

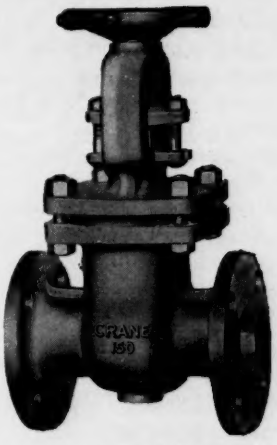
Write our Engineering Service Department for copy of this new 32-page illustrated catalog on Byers PVC Pipe.

valves that beat your corrosion problems

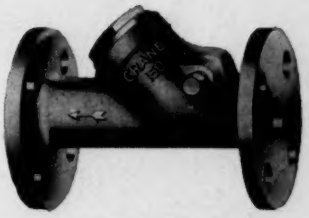
Crane 18-8 SMo and "Craneloy 20"



Globe and Angle Valves



Gate Valves



Swing Check Valves

CRANE CORROSION RESISTANT VALVES

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

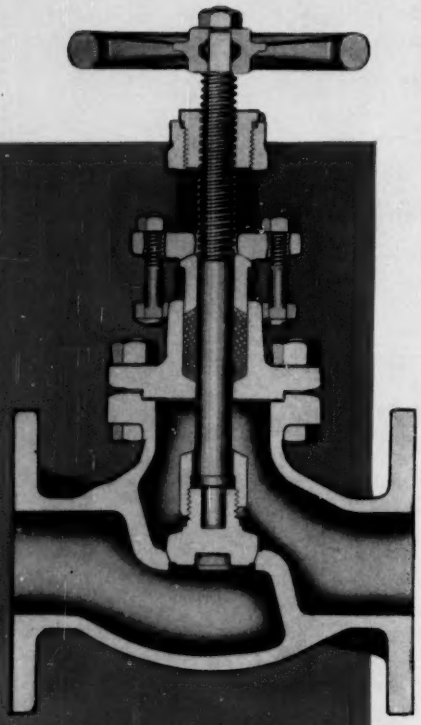
Since 1855—Crane Co., General Offices: Chicago 5, Ill.—Branches and Wholesalers Serving All Areas

CRANE

18-8 SMo and "CRANELOY 20"

GLOBE and ANGLE VALVES

with Swivel Disc



Performance-proved for sensitive flow control and positive sealing of highly corrosive fluids, vapors and gases

These corrosion-resistant valves were designed and perfected by Crane to combat the principal causes of valve damage: erosion, cutting and scoring. The stout heart of these valves is the

IMPROVED SWIVEL DISC-STEM DESIGN

The disc is a modified plug type, combining the easier seating of a narrow ball-to-flat seat and better resistance to erosion and scoring provided by a wide, plug-type disc.

In addition, Crane's exclusive "guided disc" design brings the stem thrust closer to the seating surface and assures positive closure. Minimum clearance between disc and stem eliminates vibration and chatter, but permits free swivel action at the disc-stem connection. As a result, the disc seats firmly with minimum torque and without galling and seizing.

All parts of these valves in contact with flow are Crane 18-8 SMo or "Craneloy 20," cast by Crane under closest supervision. See page 4 for composition of Crane 18-8 SMo and "Craneloy 20."

OTHER DESIGN FEATURES

Body. Designed for smooth flow with minimum pressure drop and turbulence. Seats are integral.

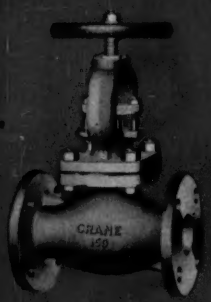
Bonnet. Bolted OS&Y. Body-bonnet joints are retained gasket type. Stainless steel bolts, four or more, are used.

Packing gland. Two-piece, ball-type. Maintains uniform pressure on packing without danger of binding stem. Stainless steel carriage bolts are used.

Materials. Body, bonnet, stem, disc assembly, and packing gland —Crane 18-8 SMo or "Craneloy 20." Yoke bushing—cast manganese bronze. Teflon bonnet gasket. Teflon packing.

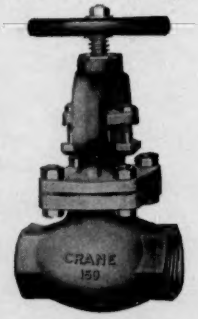
WORKING PRESSURES AND SIZES. Ten sizes, ½" to 6". 150 psi at 500 F; 230 psi at 100 F. Screwed and flanged ends. Flanged facings have serrated finish. All valves OS&Y.

Close-up of Crane swivel disc-stem connection. Minimum clearances between disc and stem prevent vibration and chatter. Long "guide" on end of stem assures accurately aligned seating.

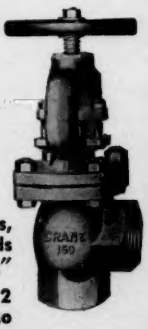


Globe valves, flanged ends ½" to 6"
No. 18811 18-8 SMo
No. 20011 "Craneloy 20"

Globe valves, screwed ends ½" to 2"
No. 18810—18-8 SMo
No. 20010—"Craneloy 20"

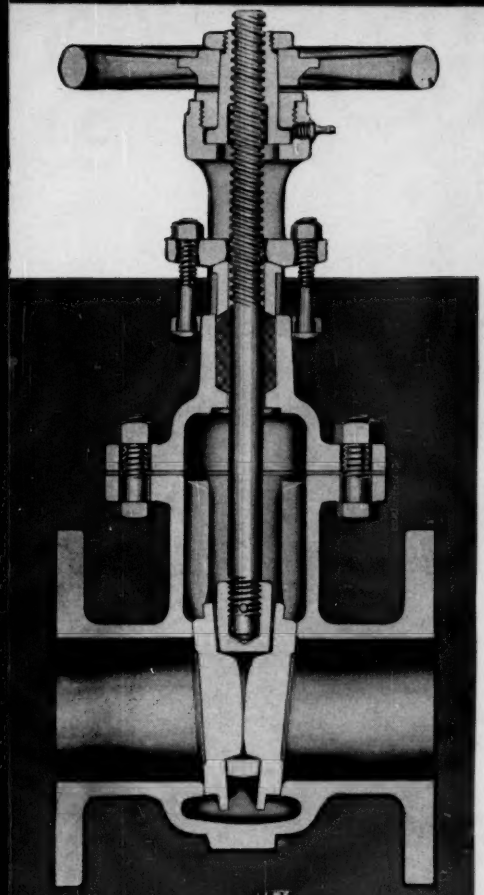


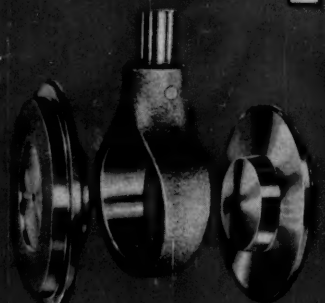
Angle Valves, flanged ends ½" to 6"
No. 18813 18-8 SMo
No. 20013 "Craneloy 20"



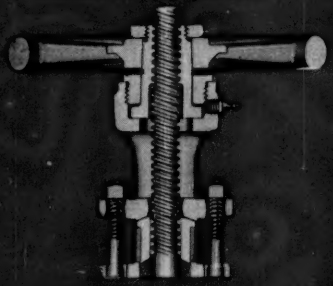
Angle valves, screwed ends ½" to 2"
No. 18812 18-8 SMo
No. 20012 "Craneloy 20"

CRANE





Crane split-wedge disc design. Identical disc halves assure uniform seating pressure.



To facilitate easy opening in valves 2½" and larger, Crane provides a groove fitting for drain installation.

18-8 SMo and "CRANELOY 20"

GATE VALVES

with Split-Wedge Disc

Designed for long life, tight seating, easy operation and low cost maintenance on toughest corrosive services

Corrosion . . . wear . . . galling . . . seizing—all costly enemies of valves in chemical processing plants—meet their match in Crane 18-8 SMo and "Craneloy 20" gates.

Key to the success of these popular valves is the unique seating design perfected by Crane. The potential weaknesses of ordinary split-wedge disc valves used on corrosive services have been eliminated.

CRANE SPLIT-WEDGE DISC DESIGN

This simple construction features identical disc halves (an exclusive Crane development), which means that seating loads are transmitted equally to each half, assuring uniform pressure on seating faces. There is no danger of buckling a weaker disc member, as in conventional ball and socket disc construction. In opening, the first turn of the handwheel frees the discs—even if the valve is closed hot and opened cold.

Special guide flanges on the discs, *another Crane feature*, prevent disc drag across the seat during operation. This means longer seat life. The free-to-rotate discs prevent concentrated wear, galling and seizing.

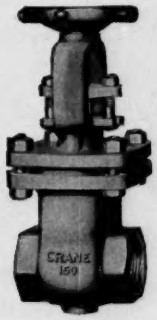
All valve components in contact with flow are Crane 18-8 SMo or "Craneloy 20." All castings are produced under rigid control in Crane's own foundry. Stuffing boxes are packed with tough, resilient, non-contaminating Teflon.

CRANE QUALITY IN EVERY DETAIL

1. Internal areas proportioned for smooth flow, minimum turbulence.
2. Teflon stem packing.
3. Two-piece, ball-type packing gland. Assures uniform pressure on packing without binding stem.
4. Crane exclusive split-wedge disc assembly.
5. Teflon bonnet gasket.

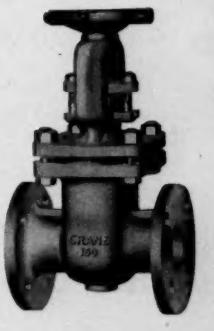
Materials. Crane 18-8 SMo or "Craneloy 20" in body, bonnet, stem, disc, disc carrier and gland. Integral seats. Stainless steel bonnet and gland bolts. Cast manganese bronze yoke sleeve. Malleable iron handwheel. See page 4 for composition of Crane 18-8 SMo and "Craneloy 20."

WORKING PRESSURES AND SIZES. 13 sizes—½" to 12". 150 psi at 500 F; 230 psi at 100 F. Screwed and flanged ends. Flanged facings regularly have serrated finish. All valves OS&Y.



Gate valves—screwed ends
½" to 2"
No. 18844—18-8 SMo
No. 20044—"Craneloy 20"

Gate valves—flanged ends
½" to 12"
No. 18845—18-8 SMo
No. 20045—"Craneloy 20"



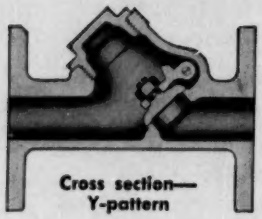
CRANE CORROSION-RESISTANT VALVES

CRANE

18-8 SMo and "CRANELOY 20"

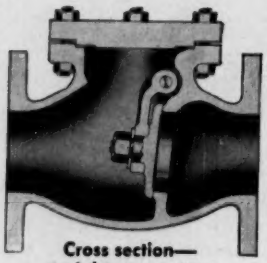
SWING-CHECK VALVES

to help maintain Crane quality throughout your piping systems



Cross section—
Y-pattern

Y-pattern valve features. Valve is equipped with an access opening in line with the seat; disc can be rotated with a screw driver to permit regrinding of seating surfaces without removing the valve from the line. Smooth interior contour assures easy flow.

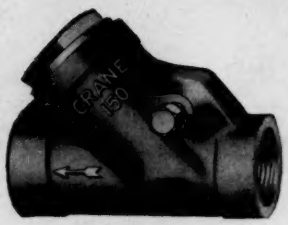


Cross section—
straightway pattern

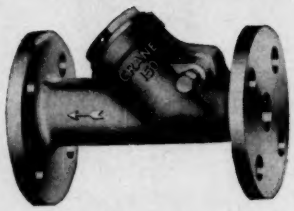
Straightway valves. Integral seat, with seat face at minimum angle from vertical to permit smooth flow with low turbulence. Cap secures tightly with stainless steel bolts and nuts, yet permits easy dismantling for maintenance.

WORKING PRESSURES AND SIZES

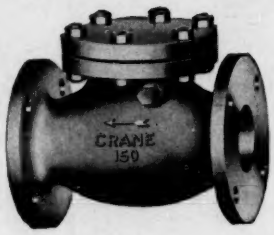
Ten sizes: Y-pattern, ½″ to 2″; straightway pattern, 2½″ to 6″. 150 psi at 500 F; 230 psi at 100 F. Y-pattern valves in screwed and flanged ends. Straightway valves in flanged ends only.



**Y-pattern—
screwed ends
½″ to 2″**
No. 18826—18-8 SMo
**No. 20026
"Craneloy 20"**



**Y-pattern—
flanged ends
½″ to 2″**
No. 18827—18-8 SMo
**No. 20027
"Craneloy 20"**



**Straightway pattern
2½″ to 6″**
No. 18829—18-8 SMo
**No. 20029
"Craneloy 20"**

COMPOSITION OF CRANE 18-8 SMo AND "CRANELOY 20"

Crane 18-8 SMo. Exceptionally high-grade stainless steel. Highly resistant to many corrosive fluids. Contains 18-22% chromium, 10-12% nickel, 2.5-3% molybdenum and under .08% carbon, *exceeding* the minimum requirements of ASTM Specification A-351, Grade CF-8M. Corresponds to AISI Type 316 wrought stainless steel.

"Craneloy 20". This high-nickel, high-chromium stainless steel was developed as a well-balanced alloy having a high order of resistance to a wide range of sulfuric acid concentrations at elevated temperatures. Contains 28-30% nickel, 19-21% chromium, 3.6-4.5% copper, 2-3% molybdenum and under .08% carbon.

High nickel content permits alloy to contain substantial amounts of copper and molybdenum, which are essential in reducing attacks of sulfuric acid. High chromium content further insures good resistance to oxidizing media, permitting the use of "Craneloy 20" on applications where other grades of stainless steel have not proved entirely satisfactory.

SPECIFICATION DATA AND APPLICATION GUIDE FREE ON REQUEST

Get this 12-page circular—AD-2080. Gives you complete descriptive and specification data on these Crane corrosion-resistant alloy valves. Includes a helpful application guide covering many corrosive fluids. For your copy, contact your nearest Crane branch or Crane wholesaler, or write to the address below.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill.—Branches and Wholesalers Serving All Areas

WHEN YOU INSTALL ALUMINUM CONDUIT...

be sure you install

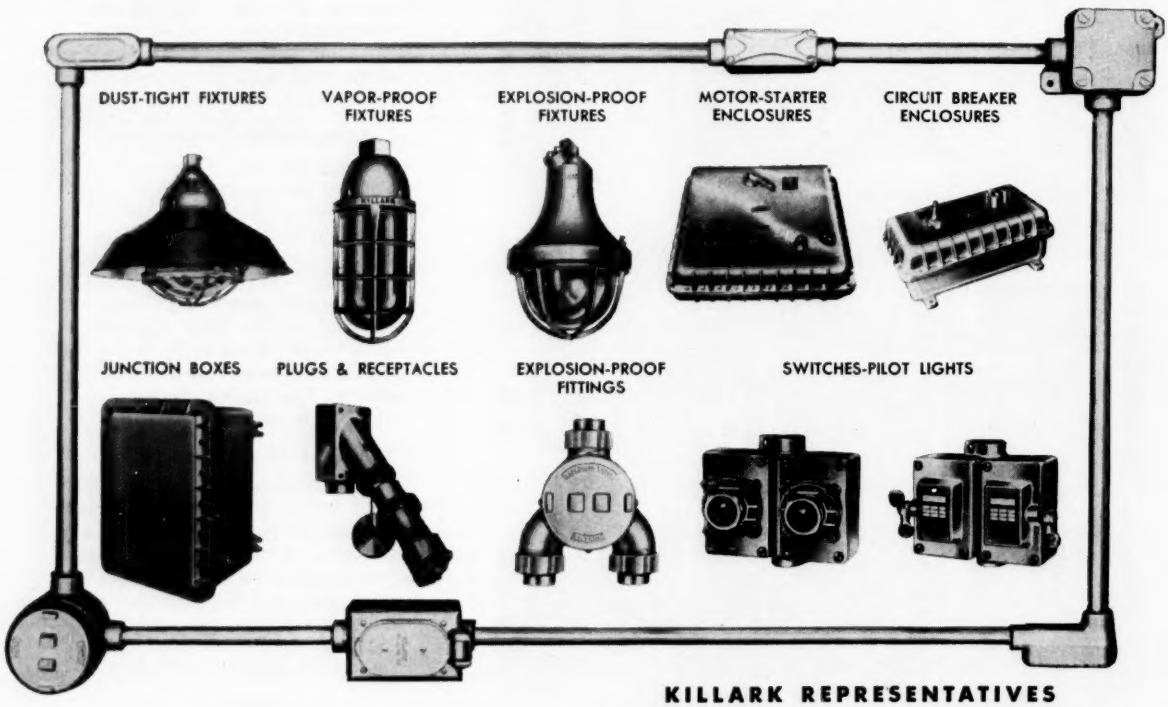
Killark Aluminum Fittings

ENJOY THE PLUS ADVANTAGES OF 100% ALUMINUM INSTALLATION

You'll have a better installation if you connect your aluminum conduit with Killark aluminum fittings and fixtures. You get: *Lightweightness.* A labor savings in installation costs . . . ⅓ the weight of iron, one man can handle the work of two. *Non-Corroding Durability.* Smooth, bright, non-rusting . . . long on life, short on maintenance. *Easy Installation.* Clean threads, plenty of wiring room. *Safety.* Non-sparking, an important factor in hazardous areas.

The First and Most Complete All-Aluminum Line

Whatever the installation, there are thousands of fittings in the ever-expanding Killark line from which to choose. And behind each are many years in pioneering, researching, designing and development of the finest aluminum fittings at the lowest possible cost.



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ELECTRIC MANUFACTURING COMPANY

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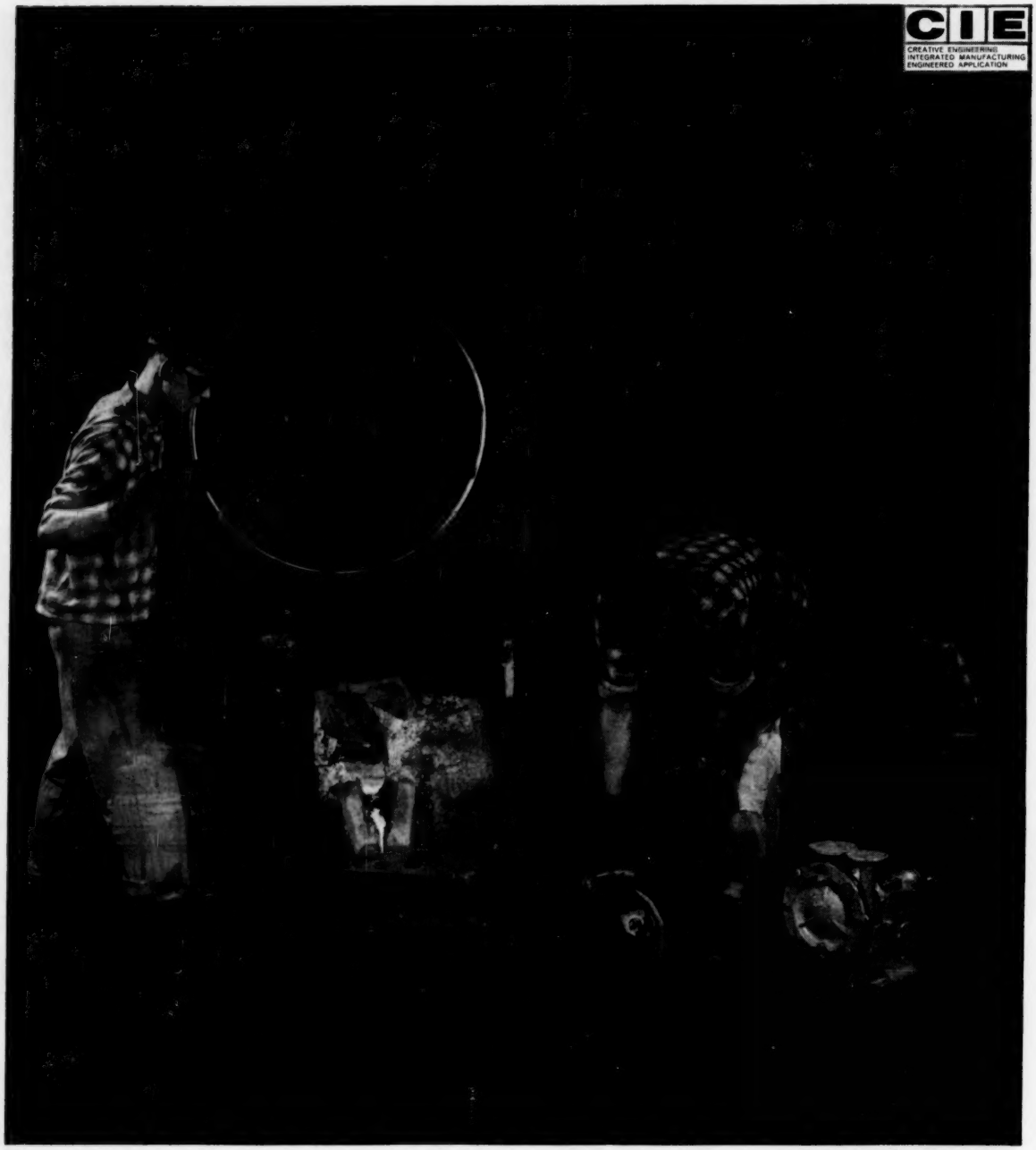


INTEGRATED MANUFACTURING guides Goulds pumps through the foundry, machine shop and assembly plant to you.

Result? You get a pump that's made to order for the job it must do.

Manufacturing pumps "from foundry to finish" also cuts costs. That's why you get a *better* pump from Goulds—made from high-quality, precision parts—at no greater cost than other pumps.

And, because it's not a mere assembly job, a Goulds pump can be designed and built for interchangeability —to cut your spare parts inventory and maintenance costs.

To completely control the production of our designs, we had to build the world's largest plant devoted to the manufacture of pumps exclusively. Over 100 years of experience gives us the know-how.

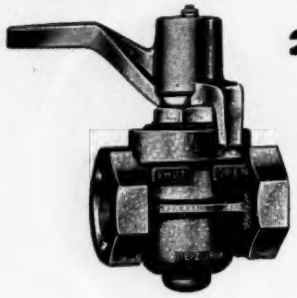
For help in solving *your* pumping problem, write to Goulds Pumps, Inc., Dept. CE-79, Seneca Falls, N.Y.

GOULDS GP PUMPS

Certified Leak Rate*:
less than .01 micron cfh thru the stem seal . . . less than .003 micron cfh seat leakage!
*** on 3" DeZurik Valve**

...Here's a high vacuum valve you can DEPEND on!

1. Long Maintenance-Free Service Life



2. Extremely Low Leak Rate

3. Straight-Thru Flow for Low Impedance

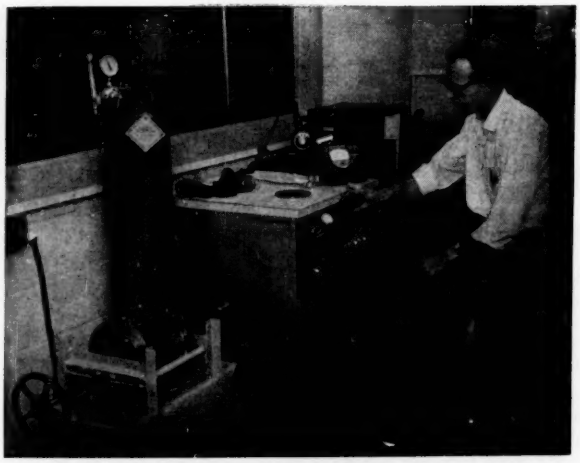
4. Low Initial Cost

Used on high vacuum, air release or throttling service, DeZurik Valves combine the unique advantages of eccentric action and resilient plug facing to provide the special requirements of high vacuum service.

Their simple, positive action assures longer service life with less maintenance.

On such vacuum services as solvent recovery, oil deodorizing, molecular distillation, vacuum fusion analysis and others, DeZurik Valves are the dependable, low cost answer.

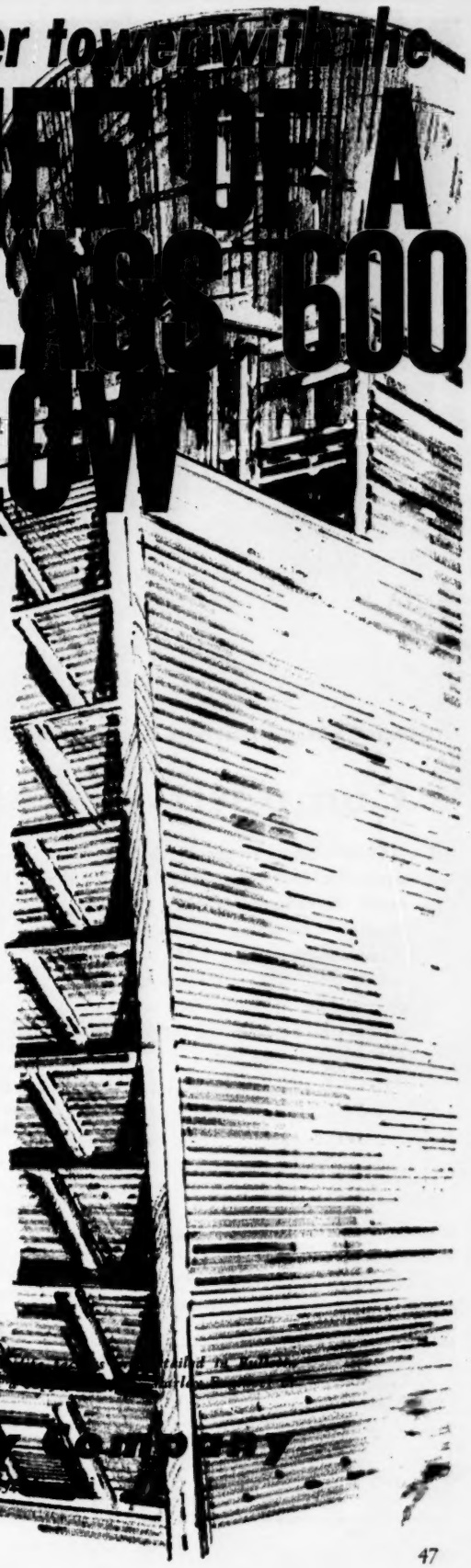
DeZurik Valves for vacuum service are available in sizes from ½" to 20" and in manual or remote operated models. See the DeZurik representative near you, or write for details.



Each DeZurik high vacuum valve is tested before shipment. Tests are made with the most accurate equipment available, a Helium mass spectrometer type leak detector

DeZURIK CORPORATION
SARTELL, MINNESOTA.

You can't buy any other tower with the SERVICE LIFE OF A MARLEY CLASS 600 DOUBLE-FLOW



Years . . . many more years than those now considered usual service life of cooling towers . . . are engineered into every Marley Class 600 Cross-Flow. Years of full performance; years of low maintenance; years for longer amortization. By incorporating (after comprehensive research) modern inert materials and protective processes throughout Class 600 design, Marley engineers have achieved an over-all durability that prolongs tower life expectancy beyond any current norm.

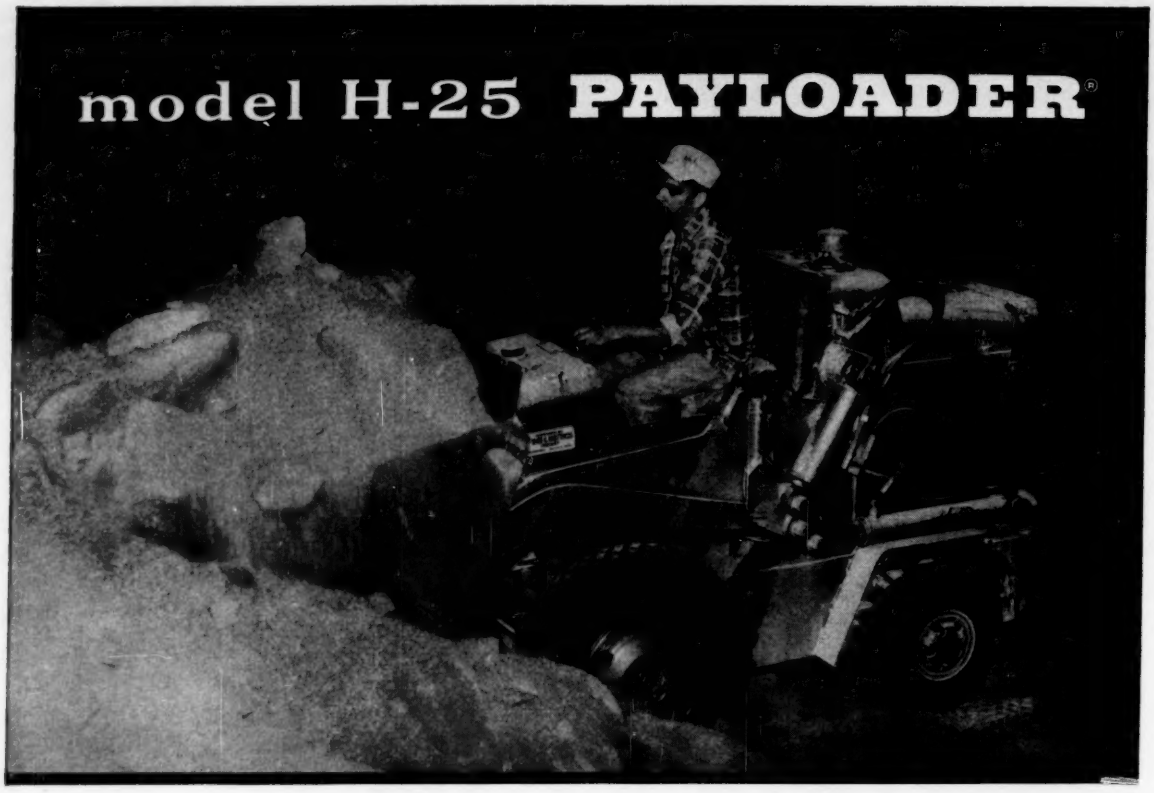
GLASS FIBER REINFORCED POLYESTER —steel-strong and impervious to corrosion—makes many components invulnerable to corrosion and decay; GRP molded **Fan Blades** are shatter-proof, shock resistant and completely unaffected by moisture or corrosive atmosphere. **GRP Fill Support Grids** position fill bars perfectly and permanently—no nails needed. **GRP Timber Connectors, GRP Retaining Rings** and **GRP Fan Cylinder Positioning** cannot corrode nor are they subject to oxidation that encourages decay in contacted lumber . . . they add vitality to critical areas, as do **Ceramic Timber Ring Connectors** and **Louver Supports** molded of rigid linear polyethylene.

ASBESTOS CEMENT BOARD — fire-safe and wear-proof—forms casing walls and wide, functional louvers that characterize Class 600's.

MARLITH PRESERVATIVE TREATMENT is life-insurance for tower lumber. Applied after fabrication, every piece of wood is deeply and thoroughly impregnated with toxic, proven protection against rot and decay.

MARLEY®

The Marley Company



Competitive Tests Prove H-25 Best

Eastern States Farmers Exchange, Inc. purchased four "PAYLOADER" units as a result of competitive tests conducted at their Cambridge, Mass. plant. In these tests, a Model H-25 "PAYLOADER" moved material at a rate of 90 cu. yds. per hour on a 150-ft. (one-way) haul distance — outproduced the other tractor-shovels in the test.

This fertilizer manufacturer serves Pennsylvania, Maryland and the New England States . . . has four plants and a fifth under construction.

One way to be sure you buy the very best in tractor-shovels is to conduct competitive tests in *your own* plant under *your own* conditions. Like Eastern States Farmers Exchange, you'll find that such tests help to cut through the confusion of conflicting claims.

More For Your Money

There are many reasons why the Model H-25 will dig, carry and deliver more yardage or tonnage with lower operating and maintenance costs than anything in its class. It has more breakout force, 4,500 lbs.; equal or greater carrying capacity, 2,500 lbs.; the shortest turning radius, 72 inches; power-shift transmission with two speeds forward *and* reverse; power-steer; exclusive power-transfer differential.

An Ounce of Prevention

The H-25 has been engineered to provide extraordinary protection against dust and dirt damage: triple air cleaner — precleaner and two oil-bath air cleaners; cartridge-type oil filter on all three oil systems; sealed, self-adjusting service brakes; parking brake enclosed in transmission; special grease and oil seals on all vital points.

Why not find out what a Model H-25 can do on your work? Ask your Hough Distributor for a demonstration, and ask about Hough Purchase and Lease Plans too.

THE FRANK G. HOUGH CO.
754 Sunnyside Ave., Libertyville, Ill.

Send data on new H-25 "PAYLOADER"

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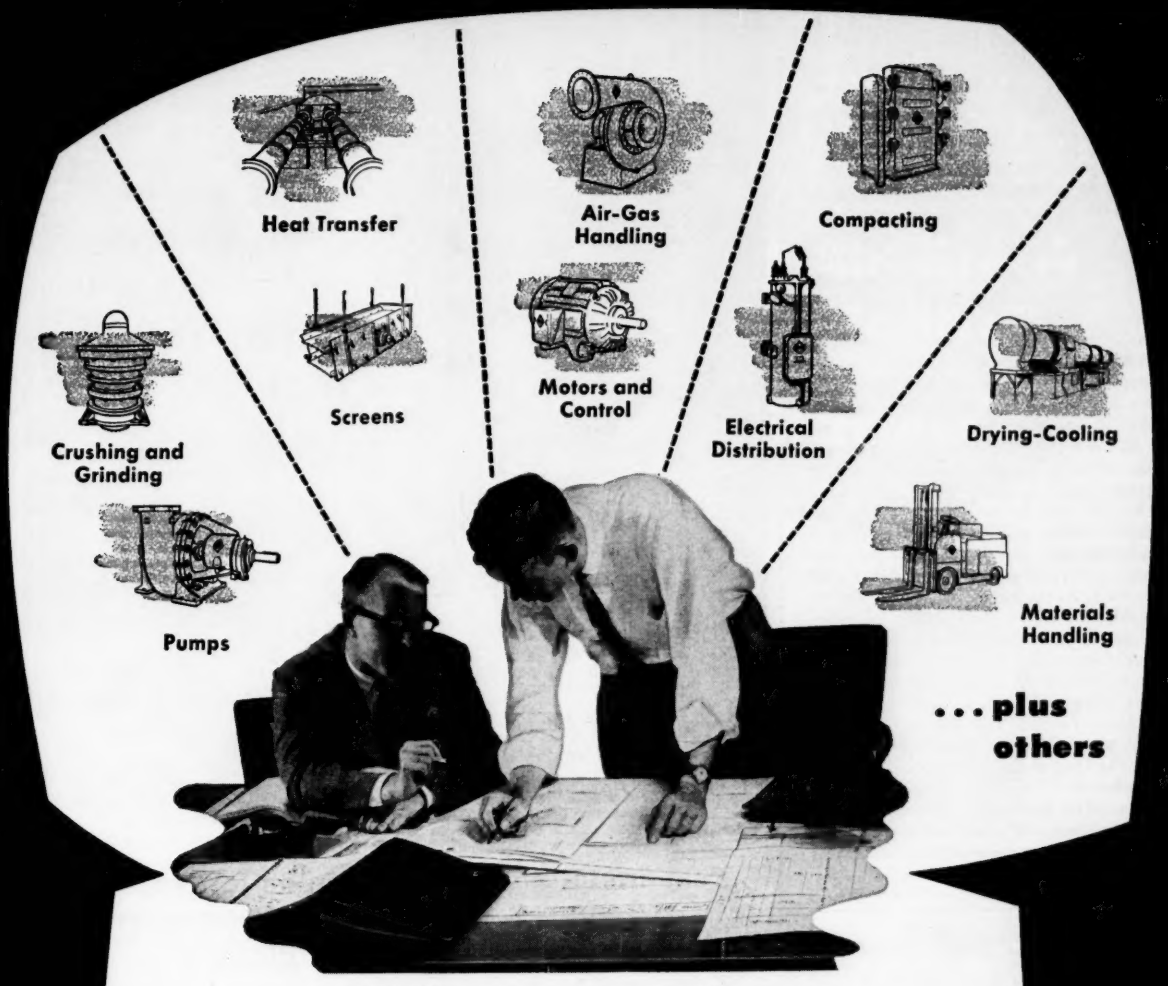

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He's your Allis-Chalmers representative. *One inquiry* to him and much of the equipment for any process expansion or modernization is available.

Time and money-saving advantages of this single source are obvious. Further, you're assured of "teamed" equipment, engineered by A-C chemical industry specialists. And, once installed, this equipment continues to be backed by outstanding field service.

ASK "THE MAN" about the tremendous scope of A-C equipment for petro-chemicals... equipment that's built for the finest quality control. Or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Products for Petro-Chemicals: *Electrical Generation, Distribution and Utilization Equipment; Pumps (rotary vacuum and centrifugal); Compressors; Mechanical Power Transmission Equipment; Processing Machinery (mills, kilns, screens, etc.); Water Conditioning Systems, plus Materials Handling Equipment.*

A-C ALLIS-CHALMERS

A 5983 C

Why the simplest trapping method is also the most economical

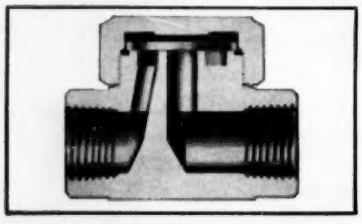
by John W. Ritter, Test Engineer
SARCO Company, Inc.

The function of all steam traps is to release condensate and prevent steam loss. However, the method of trapping can make a great difference in cost and effectiveness.

In the Sarco Thermo-Dynamic® Steam Trap, the method is fundamental. Air or condensate entering the trap must flow from the inlet tube, radially across the underside of the disc valve, to the outlet. The space between the inlet tube and the disc forms a nozzle in which the static pressure energy of the incoming fluid is partly changed to velocity across the underside of the disc, with a resultant *decrease* of pressure. (This will be recognized, of course, as the Bernoulli Principle.) Use of this fundamental method means reliability in operation.

As the high-velocity fluid jet strikes the side of the upper chamber, some recompression takes place, so that the pressure above the disc becomes greater than the pressure below it. The pressure reduction under the disc and the pressure recovery above it depend on the internal energy of the fluid. As the condensate above nearly approaches steam temperature, its internal energy is enough to overcome the upward force at the inlet tube, and the disc snaps down in the inlet tube, which is the inlet valve seat.

Simultaneously, the disc also seals the outer ring, which isolates the space above the disc from the outlet. The disc valve is therefore held firmly against the inlet valve seat until the pressure in the control chamber is reduced by condensation. The upward force then exceeds the downward force and the disc valve opens.



This 3-part Sarco TD-50 Steam Trap has only one moving part — the hardened, polished stainless steel disc.

No other trap uses the velocity of the fluid to operate the valve or the recompression of the flowing fluid to trap the valve closed and to hold it closed. When it closes, it closes tightly — no "operating steam" leaks out.

This tracer line manifold at the Armour Chemical plant at McCook, Illinois, is drained by eleven Sarco TD-50 Steam Traps.

Test installation led to selection of SARCO TD-50 Steam Traps at Armour's McCook Plant

Test installations of Sarco Thermo-Dynamic® Steam Traps at the McCook, Illinois, plant of the Armour Chemical Division showed satisfactory performance on all requirements specified by the plant engineers. The TD-50's discharged condensate as fast as it formed, without wasting live steam. TD's inline construction made installation easy, even in tight quarters. Maintenance was practically negligible, and no adjustment was necessary for varying steam pressures. In the plant, steam pressure of different processes ranges from 15 to 160 psi. Armour's McCook plant began to install TD-50 Steam Traps in 1956 and continued to add them as the plant expanded. By the third quarter of 1958, there were 309 TD-50's in use there.

Write for your "Literature Kit 2A" today and get latest bulletins on the TD-50 Steam Trap and other Sarco traps. Sarco can give you impartial advice on *Production Planned* steam trapping because . . .

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COMPANY, INC.
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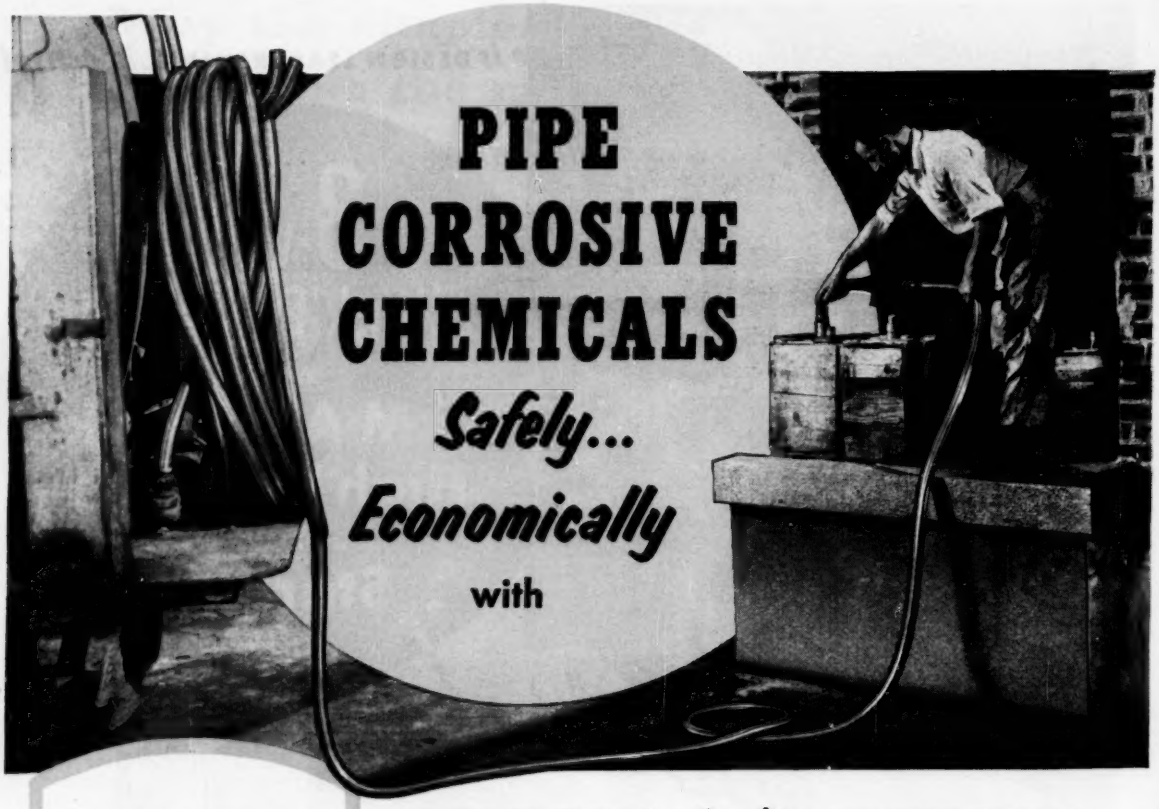

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- 65 Sizes to 4" O.D.

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439-F

DEVELOPMENTS . . .

JULY 27, 1959

Chementator

C. H. CHILTON

Shell Chemical Co.'s plan to build a commercial-scale polyisoprene plant is moving ahead with construction start on 20,000-ton/yr. plant at Torrance, Calif.

By August 1st, Alpha Mining and Milling Corp., affiliate of Minerals Refining Co., will be producing pure columbium and tantalum continuously via new solvent extraction process at North Salt Lake City, Utah.

Tidewater Oil Co. soon will move into petrochemicals in a big way with a worldwide program costing hundreds of millions of dollars. Discussions with major chemical companies may lead to joint ventures.

San Francisco Chemical Co. will construct plant at Leefe, Wyo., to defluorinate 6 tons/hr. of phosphate rock for animal feed supplement using a new process.

Engineers enjoy union-won status

If you oppose unionization of engineers on the grounds that engineers thereby lose their professional identity, take a look at these contract provisions won this month by Boeing Airplane Co. engineers at Seattle and Wichita:

• Company will supply its professional engineers with identification badges different in color from those issued to non-engineers.

• Title blocks on drawings will now provide space for the engineer's name in addition to those of draftsman and checker. Seattle Professional Engineering Employees Assn., representing the engineers, contended that the former title block was a relic of the period when all drafting was done by engineers and that the change emphasizes the different function of the engineer.

• Company agreed to accelerate its employee reclassification program so that professional employees would all get exempt status (according to wage-hour laws) and, by the same token, employees who cannot qualify for exemption would be transferred to non-engineer classifications.

For the third straight year, Boeing will give its engineers an across-the-board salary hike in accordance with the previously established principle of detelescoping (*Chementator*, July 1957, p. 141). Increase this year amounts to 3.5%, the difference between Boeing starting salaries this year and last.

Order your ethylene via tank truck

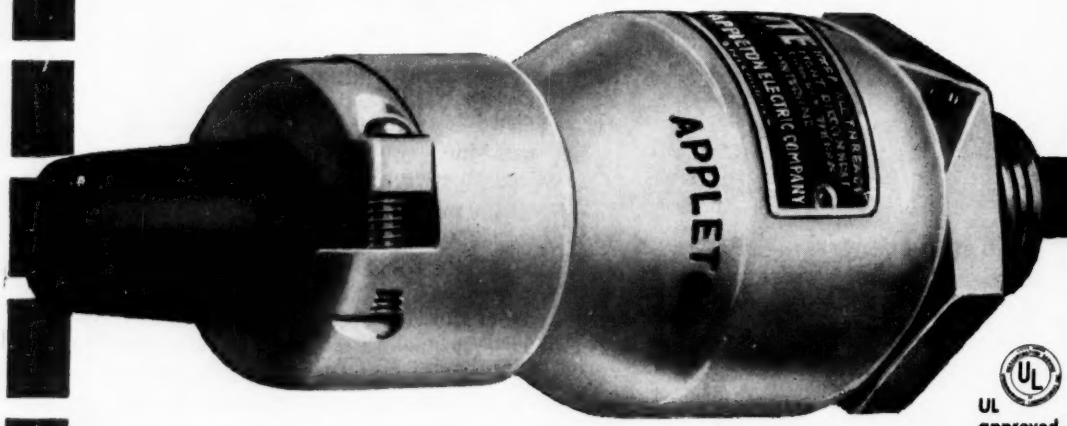
A new dimension in petrochemical manufacture opened up last month as bulk shipments of liquid ethylene began for the first time on this continent.

Using two special tank trailers, each holding 30,000 lb., Imperial Oil is now making regular deliveries of liquid ethylene from Sarnia, Ont., to Union Carbide Canada at Montreal East, 18 hours and 536 miles away. And Imperial is also shipping liquid ethylene via an-

APPLETON type "ECC"

explosion-proof, dust-proof cable connector

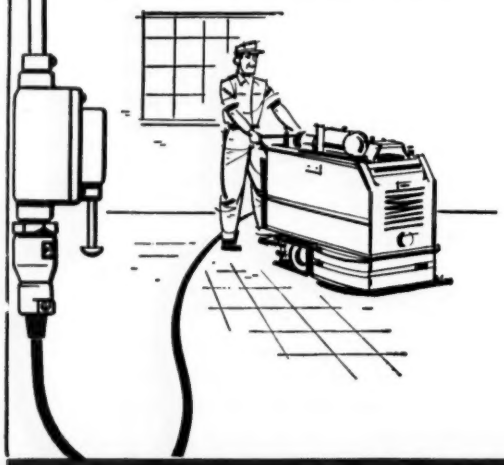
(CLASS I, GROUPS C and D; CLASS II, GROUP G)



UL approved

A factory-sealed, explosion-proof connector used between a portable extension cord and an explosion-proof unilet or housing

Illustration shows an APPLETON "ECC" Explosion-Proof Cable Connector in use with a portable Floor Scrubber.



From its rugged aluminum housing which withstands years of extreme rough usage, to its lead wires protruding 12" from the body for faster, easier splicing, this APPLETON "ECC" Connector has every desirable quality feature.

The current carrying lead wires for example, are solidly moulded into the connection blocks: can't work loose under vibration. An auxiliary cord clamp is provided to prevent strain on the wire connectors resulting from sudden tugs on the cord. This clamp fastens tightly by screw pressure on a tapered rubber bushing in the form of a sleeve... effectively sealing the cord entrance. Three pressure-type solderless lugs on the load end of the "ECC" allow quick connections to be made with Type S Rubber-Covered Cord in ranges of #18 to #12, AWG. The grounding connector is plainly identified with a letter "G" on the block. Only the APPLETON Type "ECC" Explosion-Proof, Dust-Tight Cable Connector offers so many worthwhile features for such an economical price.

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APPLETON ELECTRIC PRODUCTS

Also Manufacturers of:


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Reelites

other truck to a Buffalo-area chemical plant.

Although liquid ethylene has moved in commercial channels previously in Europe, over here bulk transport of ethylene has been entirely in gaseous form by pipeline. (Minor quantities are also shipped at high cost in compressed-gas cylinders.)

Ethylene-consuming plants have perforce been located near ethylene supplies. Bulk shipment by tank will permit the petrochemical producer to cut this umbilical cord and choose his plant location with greater freedom.

Carbide originally built its ethylene trailers with the idea of using them for shuttle service between Texas City and Seadrift, Tex. The expected ethylene surplus at Seadrift failed to materialize, but a shortage developed at Montreal East. So the trailers were hauled up to Canada for service there instead. Imperial has leased them from Carbide.

Each tank is 78 in. I.D. by 34 ft., 9 in. long, made of stainless steel. They are covered with about 9 in. of expanded polystyrene insulation. Ethylene is loaded at its atmospheric boiling point, —155 F. Tanks are so designed that they can stand for a week in the summer sun, even in Texas, without popping the relief valves.

Signs point to major pulping shift

Based on orders now swelling the books of the Swedish Kamyr Co., North American pulp makers definitely have turned to continuous pulping for their new mills.

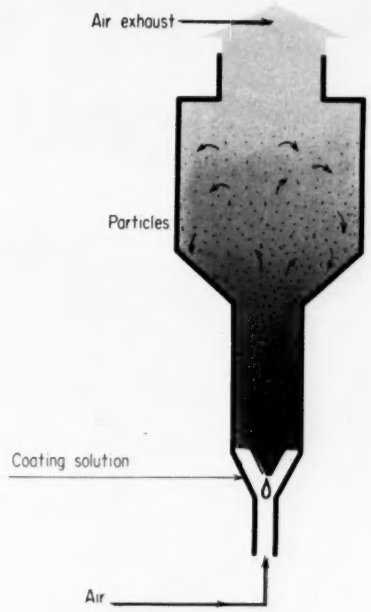
Next month, Kamyr will start building a 350-ton/day continuous digester for the new Robert Gair mill at Augusta, Ga. On order are two more similar units for a 600-ton/day installation at Celgar, Ltd., Castelgar, B. C. But even more than these commitments, negotiations now under way accent the quickening tempo of growth for continuous pulping; they outnumber Kamyr's seven North American installations built, abuilding or on order since its debut here in 1956.

Why pulpers are installing continuous digestion becomes obvious from Kamyr's reported experience. A straightforward adaptation of batch digestion, the liquor-filled vertical Kamyr tower continuously impregnates and digests downflowing chips under normal time and temperature conditions. But the pulp is more uniform and stronger than batch pulp.

Even so, Kamyr uses 50% less steam at a uniform rate that eliminates peak demand, thereby reducing boiler size. Operating full of liquor, the digester doesn't corrode. And one man per shift is total operating labor.

Having established a foothold primarily in kraft, Kamyr now is developing continuous units specifically for corrugating board and dissolving pulp. Other commercial continuous digesters—Black Clawson, Sprout Waldron and Bauer Bros.—have concentrated more on semichemical pulp. Among them, there are a few units—installed or planned—for producing kraft pulp. However, they work on hardwood whereas many of Kamyr's units, here and abroad, handle softwoods.

Tablet makers eye air coating



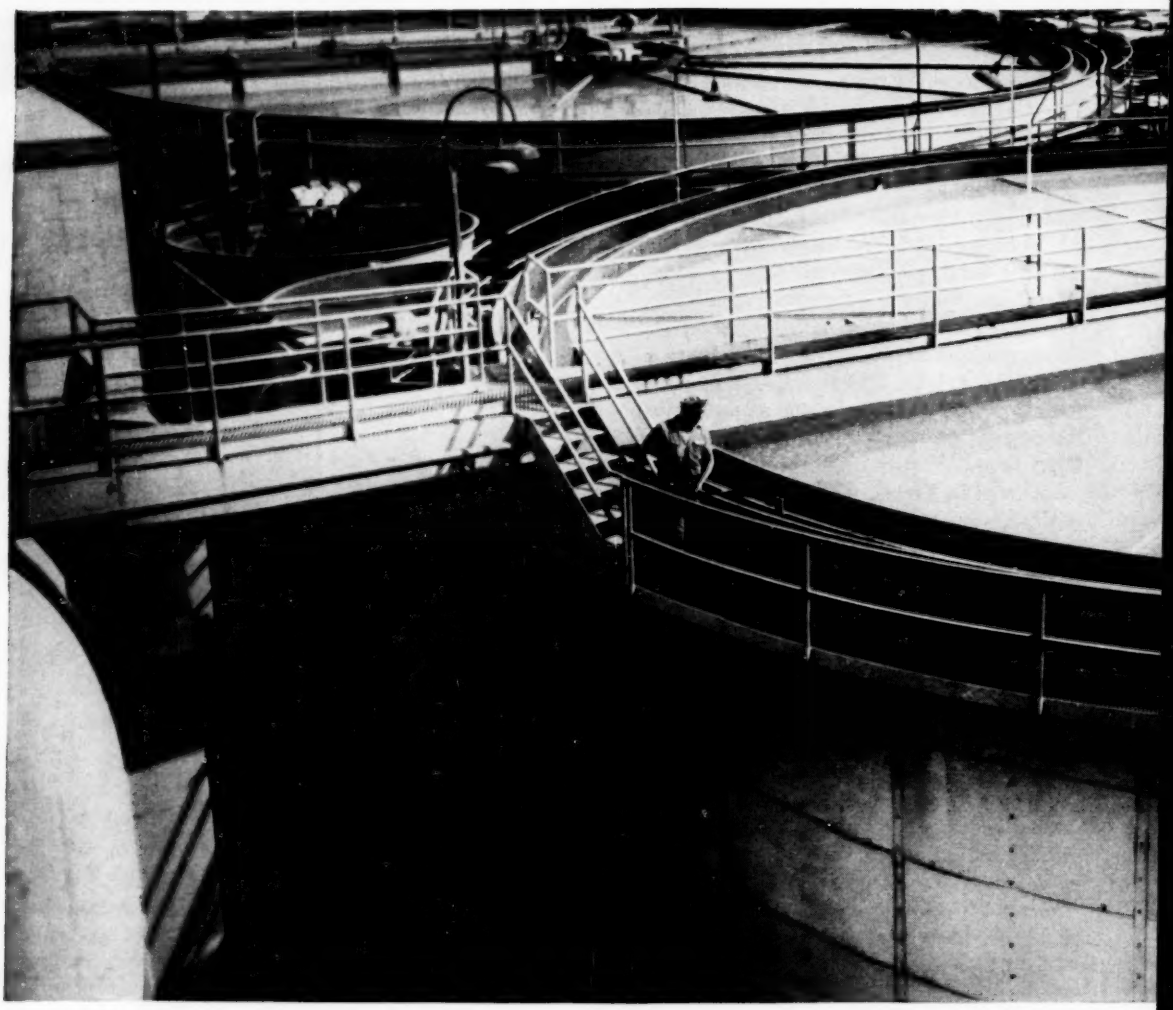
Several major drug firms, including Abbott, Merck and Smith Kline & French, are piloting particle coating by Wurster process, sketched above. Developed by Dale E. Wurster at University of Wisconsin, process is a natural candidate for forming and coating drug tablets, offers interesting possibilities for granulating other materials.

As it stands, process is an intriguing medley of fluid-bed, spray drying and atomizing techniques. Coating solution atomizes into air stream and deposits on 16-80-mesh particles suspended in stream. Among potential benefits are process's ability to:

(Continued on page 58)

At Diamond Alkali Company

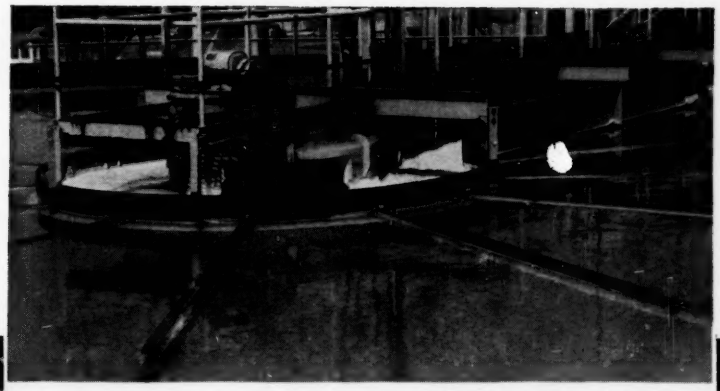
MODERN BRINE TREATMENT PLANT HANDLES LARGE CAPACITY WITH DORR CLARIFIERS



The recently modernized brine treatment plant of the Diamond Alkali Company, at Painesville, Ohio, is one of the largest of its kind in the world. Its design is the result of a coordinated research project carried out by Diamond Alkali's Research Center and Dorr-Oliver's Testing Laboratories at Westport, Conn.

Raw brine from underground wells is stored in a service reservoir, then given pre-treatment with chemicals in Dorr paddle agitators before passing to two 70′ diam. Dorr Clarifiers. The thickened underflow is withdrawn by Dorrco Diaphragm Pumps.

This installation is another example of the adaptability of Dorr-Oliver designs to meet highly specialized requirements. There is a type of Dorr Thickener or Clarifier for virtually every sedimentation or clarification problem in chemical, metallurgical and industrial processing. The long experience of Dorr-Oliver engineers is always at your service to suggest the most effective design and to work out any modifications that may be necessary. Write to Dorr-Oliver Incorporated, Stamford, Conn.—or better still, have one of our engineers call and discuss your particular application.



Close-up of Clarifier influent well (note the contrast between the treated raw brine flowing through the feed channel and the clarified product at the surface of the tank.)

LARGE PHOTO shows the two Dorr Clarifiers in operation. Units are equipped with radial beams and a submerged peripheral launder system.

• Coat particles which are too small for handling by conventional pan methods.

• Apply multiple coats in a single operation without removing particles for mixing or drying between coats.

• Granulate particles entirely within the system, building up an aggregate through successive coatings.

• Decrease coating or granulation time from hours to minutes.

Contrary to what you might expect, particle attrition "is not significant." And agitation of particles in chamber keeps solids from building up on walls. Better than 99% of coating material is utilized.

Dr. Wurster claims his equipment has successfully coated pills, animal feeds, fertilizers, insecticides, etc., with a variety of materials such as waxes, cellulose derivatives, lipoproteins and resins. Process and equipment patents have been assigned to Wisconsin Alumni Research Foundation, Madison, Wis., which intends to license the technique as widely as possible.

Line of metals chemicals now complete

With its July announcement of a line of metal acetylacetonates, Union Carbide Metals finished framing its broadside entry into metal chemicals.

This latest group follows introduction of chlorides, carbonyls, oxychlorides, oxides and phosphates of the 11 transition metals (subgroups 4, 5, 6 and 7 of the periodic table) since UCM first declared last year its intention of exploiting this field. In addition to the metal chemicals proper, framework also includes intermetallic compounds of the 11 metals as borides, carbides, nitrides, phosphides, silicides and sulfides.

In general, UCM chose these particular metal chemicals compounds because they offered the best vehicles for inserting heavy metals into various classes of end-use reactions or mixtures. Chlorides are the cheapest, most reactive liquid form of metal chemicals. Carbonyls and oxychlorides carry the metals in volatile form to facilitate making heavy metal vapors readily accessible to processors.

Unlike most of the others, acetylacetonates are end-use compounds rather than intermediates. In themselves, they have potential as ignition catalysts for jet and rocket fuels, as lubricating-oil additives to prevent carbon deposits and as stabilizers for polymers.

UCM chose to make phosphates and intermetallics because of their high-temperature stability which satisfies a growing jet-age need. And the metal oxides, offered for the first time as non-stoichiometric, sub-valence, sub-micron, finely divided particles, may have unusual value as catalysts where odd atoms can act as conductors of catalytic activity.

No bull market for '59 ChE's

	ChE's	EE's	Business
With jobs	51.1%	69.8%	42.1%
With job offers	10.7%	9.8%	11.1%
Military service	9.8%	5.9%	15.8%
Graduate study	17.9%	10.5%	8.5%
Other plans	1.0%	0.8%	0.9%
No offers, no plans	9.5%	3.2%	21.6%

This year's engineering graduates found jobs easier to come by than did last year's class, according to a survey just released by Engineers Joint Council. But chemical engineers again fared worse than other engineers.

As of May 22, according to the survey, only 5.7% of the engineering class of 1959 were without job offers or other post-graduation plans. Comparable figure for last year was 10.8% (*Chem. Eng.*, Oct. 20, 1958, pp. 171-172).

Although chemical engineers shared in this trend, aeronauticals, electricals, civils, mechanicals and metallurgicals continued in stronger demand than chemicals. Trailing the ChE's were industrial, mining and petroleum engineers.

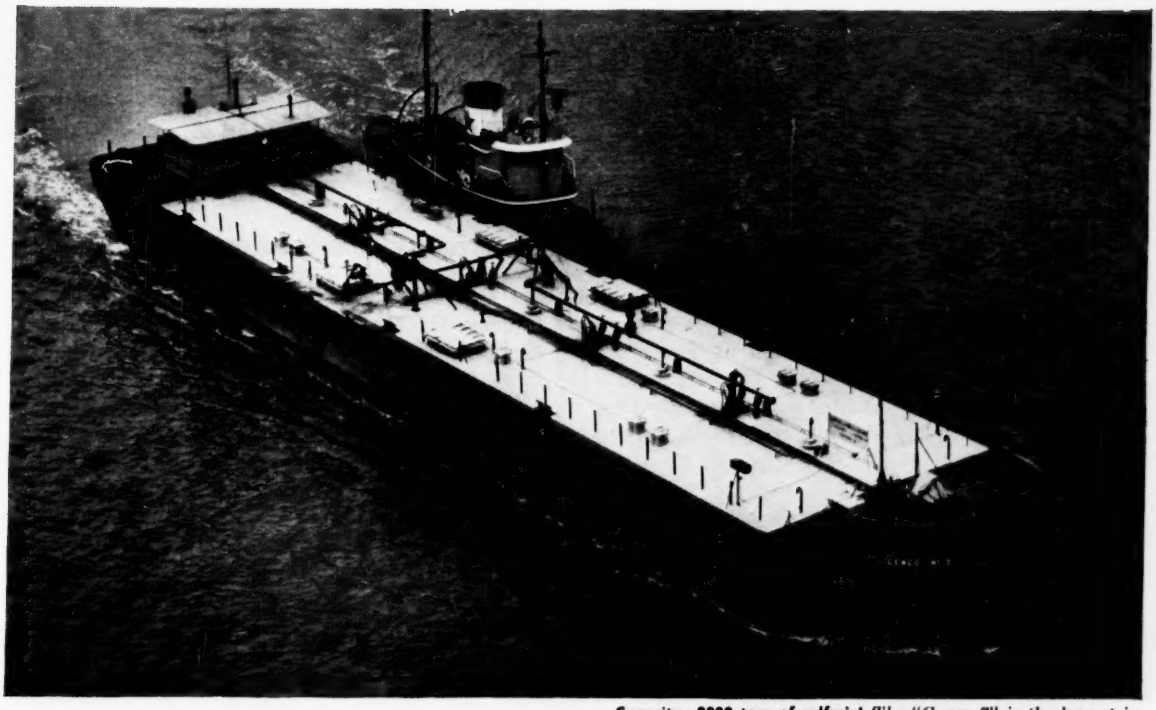
Even the worst of the engineering branches looked good compared with the sampling of business and liberal arts graduates included in EJC's survey. In these fields more than 20% of the class of 1959 was totally uncommitted late in May.

An interesting survey footnote: Graduates from curricula accredited by Engineers' Council for Professional Development found the job situation measurably tougher than did graduates from non-accredited curricula.

Frost and defrost: Key to new dry ice

Aiming at expanded use of crushed dry ice, Prof. L. Vahl, Technical Institute, Delft, Holland, has come up with a way to form match-box-size ice directly from gaseous CO_2. Following this approach, Vahl eliminates pressing, cutting and crushing operations now used to make dry ice in this form.

In his development setup, Vahl feeds



Capacity—2000 tons of sulfuric! *The "Genco 7" is the largest in General Chemical's fleet of eight sulfuric acid barges.*

Call on **GENERAL CHEMICAL** for ***Sulfuric Acid*** ...*As you need it!* ...*When you need it!* ...*Where you need it!*

Whether your sulfuric acid requirements are measured in thousands of tons or carboy lots, General Chemical is best equipped to handle your order.

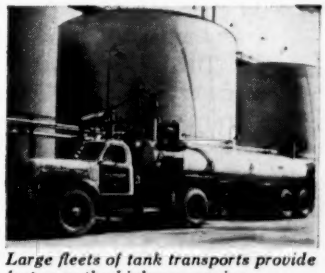
General's extensive network of production facilities plus its large and flexible transportation system assures you of sulfuric as you need it . . . when you need it . . . where you need it!

For example, we have eight sulfuric barges serving customers along the Atlantic coast and on inland waterways. Three operate out of Marcus Hook (Philadelphia), Pa. Two in the New York City area, including the 2000-ton capacity "Genco 7" shown above. Three on inland waterways. General also operates the largest fleets of sulfuric tank cars and tank trucks in the country.

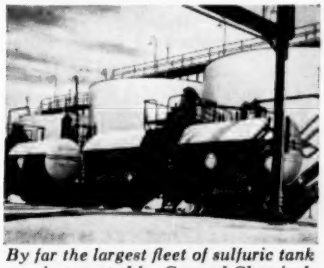
General Chemical has 21 sulfuric plants,* as well as stock points in key industrial centers across the country. Each is geared to meet regional requirements, offering customers the advantages of "next door" location to General's modern facilities. In addition, the output of one plant backs up that of another, making a coast-to-coast supply line which proves invaluable in meeting emergencies or unexpected demands.

Why not find out how our long experience and extensive facilities can benefit you? For further information, write or phone the nearest General Chemical sales office.

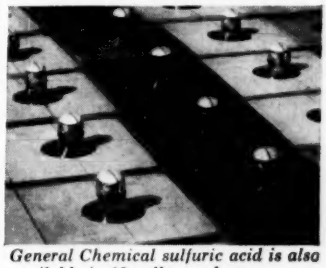
**In Canada: Allied Chemical Canada, Limited*



Large fleets of tank transports provide fast over-the-highway service.



By far the largest fleet of sulfuric tank cars is operated by General Chemical.



General Chemical sulfuric acid is also available in 13-gallon carboys.

Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N. Y.

liquid CO_2 from a cylinder through an expansion valve into the bottom of a cylindrical gas chamber. Rising through the chamber, the CO_2 gas sublimes on vanes cooled to —110 C. by circulating trichloroethylene. At this temperature, ice grows to 15 mm. thickness within 3 hr. Then temperature of the trichloroethylene is raised sufficiently to release the ice adhering to the vanes.

Trichloroethylene is cooled by Freon 22 refrigeration system acting through submerged coils in TCE tank; submerged heating element elevates TCE temperature to release dry ice from cooling vanes.

Vahl expects ultimate success or failure of his process to hinge on how efficient his engineers can make a large-scale refrigeration system.

Include inflation in earnings picture

Inflation is vying with the weather as a common topic of conversation this month, even in sweltering Washington. But regardless of whether anything can be done about inflation, its enervating effect on earnings and capital assets must be clearly recognized.

This is the aim of chemical engineering economist F. C. Jelen, author of *CE*'s well-known series of articles on the capitalized-cost method of economic evaluation.

Jelen recommends that corporation assets and earnings be viewed with the aid of a factor called "allowance for inflation." Such a factor, properly used, would spotlight the consequences of inflation and help management and stockholders assess the true performance of a company's operations.

As pointed out graphically by Sydney Steele several years ago (*Chem. Eng.*, Feb. 1953, pp. 157-161), failure to allow for the effects of inflation can give a false impression of growth and prosperity. The steel industry has been acutely aware of this situation. Studies have shown that proper allowances for inflation indicate apparent steel industry profits to be actual losses and convert apparent increases in capital assets into actual decreases.

Jelen has worked out the precise mathematical relationships between inflation allowance, yearly inflation indexes and asset values. Using these relationships—along with a proper understanding of the inflationary trends of various types of assets—engineers and economists can analyze their balance sheets and earnings statements in more intelligent fashion.

Watch for Jelen's article in our Chemical Economics department next issue.

Uncertainty sullies boron startups

Culminating many long months of effort, Callery Chemical Co. and Olin Mathieson Chemical Co. are starting up this month the two full-scale high-energy-fuel plants at Niagara Falls and Muskogee, Okla. But they are coming on stream under a pall spread by the official statement:

"The Department of Defense's Research & Engineering Director's office has initiated a study to determine the efficiency and quality of production of the Muskogee plant and the Air Force's high-energy-fuel plant at Niagara Falls, N. Y., and to make recommendations concerning them."

Unofficially we have learned that Arthur D. Little, Inc., is undertaking this study for the Dept. of Defense to determine which plant should be kept running, if decision is made to operate only one plant. Scheduled for completion within 60 days, this study could lead to shutdown of one new plant before the end of 1959.

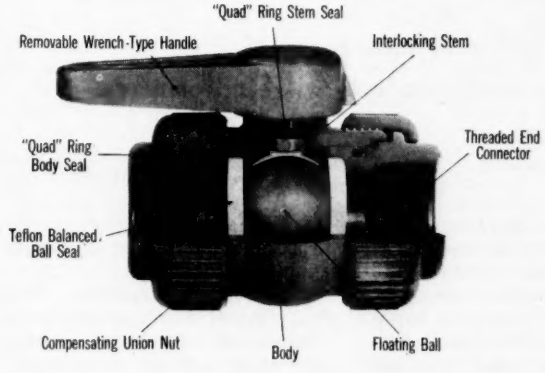
This evidence of slackening demand for high energy fuel traces directly to a shift in development aims under present budgetary policy. Boron-based fuels are intended primarily for long-range aircraft. To develop its potential use of such fuel, the Navy would have to undertake development of a new aircraft. Since this likely will not be forthcoming under present budget, Muskogee seems destined to supply Air Force rather than Navy needs, although there has been no change in original operating contract for this plant.

If the Air Force actually goes ahead with use of high-energy fuel for its B-70 and F-108 aircraft, it could use total output and more from these two new plants. But the improved performance expected from the GE J-93 turbojet slated for these ships may even cause the Air Force to forego eventual use of boron, leading to shutdown of both facilities. However, the Dept. of Defense will still probe the future of all boron-based fuels and processes through another A. D. Little study which will pinpoint the cheapest and most promising within 18 months.

For more on DEVELOPMENTS.....62

WHY COMPROMISE WITH CORROSION?

CHEMTROL PLASTIC VALVES give you these advantages–



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Chem-Check, Chem-Cock
Micro-Needle and Micro-Flow Globe Valves
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— Greatest efficiency in fluid control systems
— Economy . . . initial and long term because Chemtrol specializes in plastic valve design exclusively!

CHEMTROL BALL VALVES engineered for corrosion-service

- *Full flow . . .* no *pressure drop*
- *Continuous take-up on seat seals*
- *Self-lubricating*
- *Quick disassembly*
- *Quarter-turn opening* — positive *closing*
- *Temperature resistance up to 250° F.*

Available in basic plastic materials:
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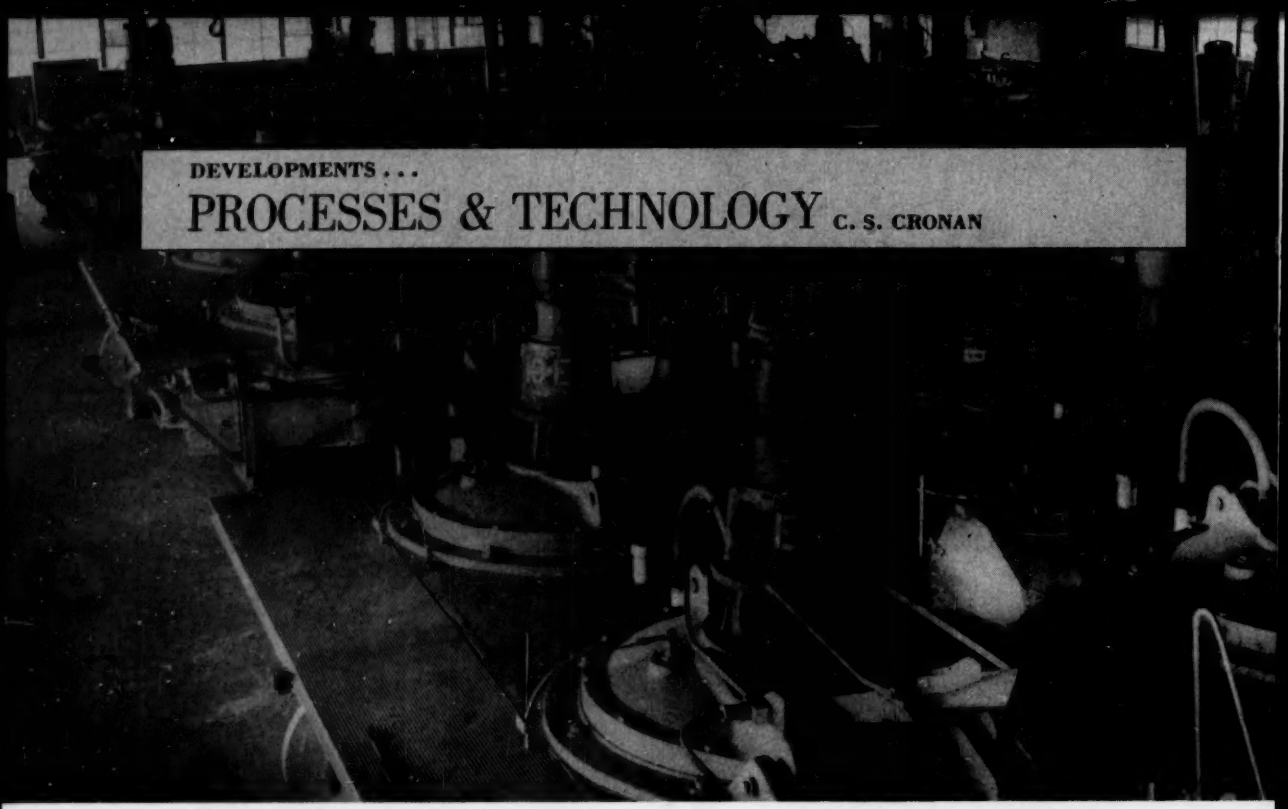
Complete research and development facilities available to you for your specific corrosion problems. Send for recommendations and "plastic chips" for solution testing. Write Chemtrol: Dept. CE 727 for Engineering Handbook 159 on designing plastic piping systems.



ACID PROCESS enables Lindsay to handle a wide variety of rare earth ores in battery of vessels at West Chicago, Ill., gives company flexibility in buying raw ore stocks.

Which Process to Free Rare Earths

Why did two major producers select different ways to convert monazite ore to finished rare earth products? Behind primary reasons are strong secondary influences.

Opinions differ on choice of a process for making rare earth and thorium compounds from monazite ore. At West Chicago, Ill., pioneer producer Lindsay Chemical Div., American Potash & Chemical Corp., uses a sulfuric acid process. But at Chattanooga, Tenn., Heavy Minerals Co. finds a caustic soda process more to its liking.

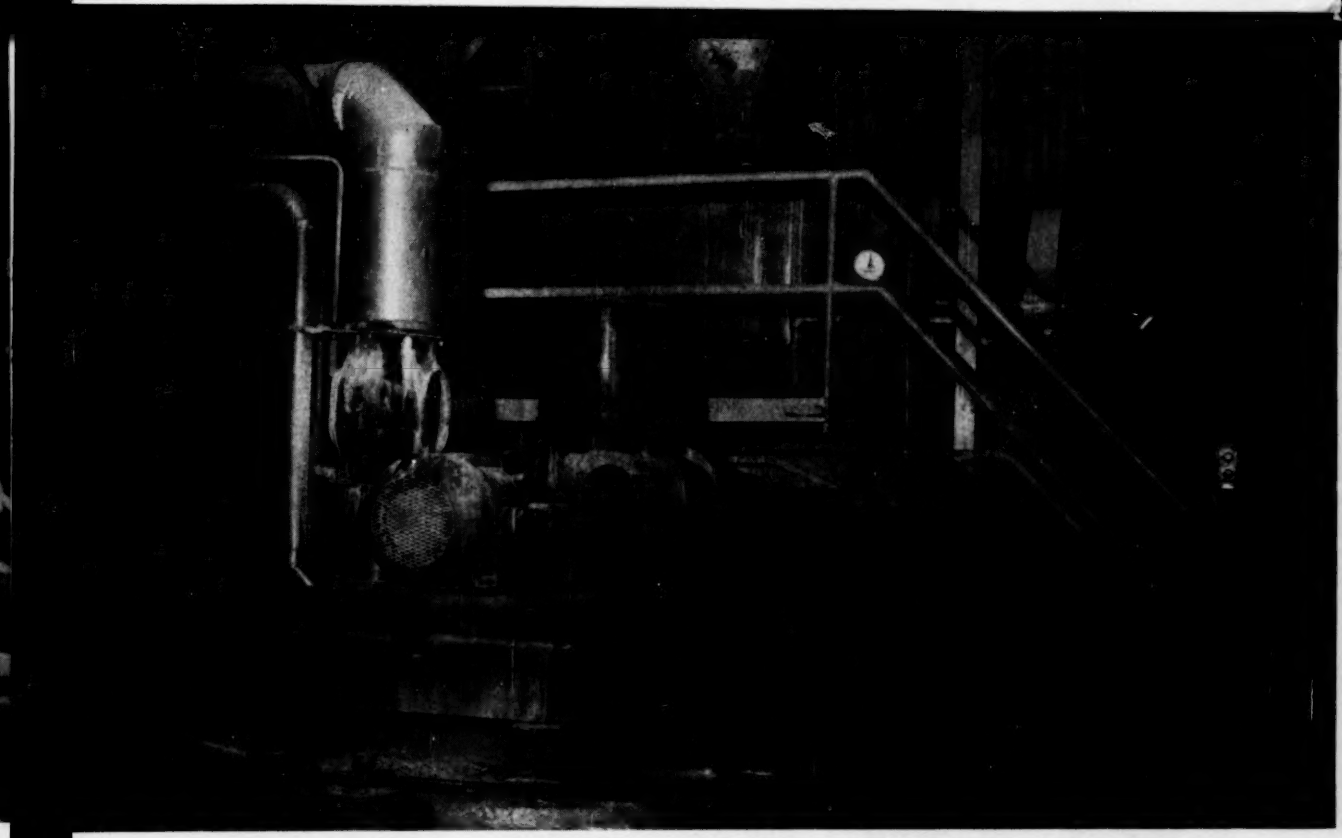
Why do these companies follow different routes to the same goal? It's simple. Secondary objectives exerted a strong influence on each company's choice of a process.

▶ **Why Acid** — Lindsay thoroughly investigated the technical feasibilities of both the acid and alkaline processes. For its type of operation, types of products produced and varying kinds of monazite ore used, Lindsay preferred the sulfuric acid process.

Using the acid process, Lindsay can handle a wide variety of rare earth ores. With this freedom, Lindsay can shop around for the best buy in ores without any worry over assay.

▶ **Why Caustic** — While Heavy Minerals lacks this flexibility, its pioneer use of the caustic process for treating monazite enables it to:

- Remove phosphate from the mineral at an early stage, simplifying subsequent separation steps and eliminating undesirable impurity from final products.
- Produce readily marketable trisodium phosphate (TSP) byproduct, recovering at least 85% yield.
- Simplify process and reduce number of steps.
- Separate pure mixed rare earths early in process in keep-



ALKALINE **PROCESS starts in battery of these vessels at Heavy Minerals, Chattanooga, takes fewer steps, yields byproduct trisodium phosphate ready for market.**

From Raw Monazite Ore?

ing with Heavy Minerals' emphasis on rare earth rather than thorium markets.

▶**Each Has Drawbacks**—From the standpoint of shortcomings, acid process poses some corrosion problems and extra process steps. But choice of the caustic soda route introduces need for costlier reagents. And ores containing less than 70% total oxides complicate caustic process filtrations and lower the purity of thorium product.

With these advantages and shortcomings in mind, let's follow through each process to see just how it works.

▶**Acid Attack** — Now using mostly South African monazite ore, Lindsay buys roughly 9,000 tons/yr. of varying grades for its West Chicago, Ill., plant. There, ore is loaded batchwise into agitated gas-fired, 750-gal. cast-iron pots to react with 2-3 parts by weight of 98% sulfuric acid per part of ore.

After heating to 400-600-F. range, reaction proceeds exothermically for 24 hr. Recovery system captures sulfuric acid fumes vented from pots.

Pot cake mixture of anhydrous sulfates of rare earths and thorium, together with phosphoric acid, discharges to 6,000-8,000-gal. agitated wooden leach tanks. Rare earth and thorium sulfates dissolve in cold water to concentration of roughly 50-70 gm./l. rare earth oxides.

▶**Major Separation** — Filtered leach liquor is treated, for example, with just enough sodium pyrophosphate solution (approximately stoichiometric quantity) to precipitate thorium pyrophosphate and leave rare earth sulfates in solution. Thorium is then processed by classical chemistry through fluoride, carbonate, nitrate, oxalate and oxide compounds.

Solution of rare earth sulfates is reacted with solution of sodium sulfate to precipitate double sulfate salts of all rare earths except yttrium earths. After filtration, solution of yttrium earths undergoes purification by ion exchange (see pp. 104-107) for production of yttrium and heavy rare earth salts. Mixed rare-earth double sulfates go on to a variety of processing stages

See Rare Earths' 2 Challenges, p. 66, Flowsheet, p. 104

depending on what particular materials are wanted.

▶**Breaking Up Rare Earths**—Easily the most used process for converting double sulfates is to hydrate them by reacting with NaOH at 212 F. in a 1,000-gal. agitated steel tank. From the hydrate, Lindsay makes mixed rare-earth chlorides, oxides and fluorides as well as various grades of individual rare earths as metals or oxides.

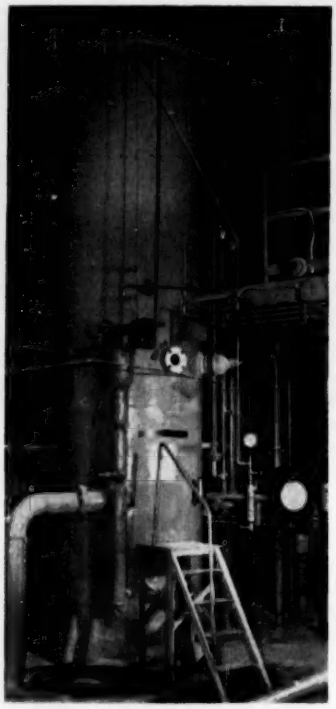
To make specific rare earths, Lindsay dissolves mixed rare earth hydrate in nitric or hydrochloric acid for a "basicity separation." By raising the pH of the acid solution to 3-4, Lindsay precipitates 95% pure cerium hydrate which can be converted directly to marketable oxide.

For higher purity product, cerium hydrate undergoes liquid-liquid solvent extraction to reduce impurities (principally other rare earths) to less than 0.01%. Then pure cerium products are converted to oxide and salts for marketing.

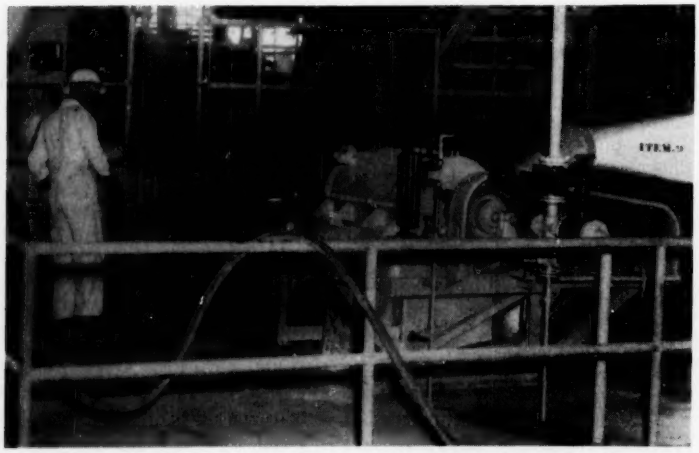
Solution of rare earths remaining from basicity separation can be precipitated as mixed hydrates, called didymium, for which there is some market. Used more frequently, however, is precipitation of remaining rare earths as carbonates. Often called didymium carbonate, this precipitate is dissolved in nitric acid and treated with ammonium nitrate to form double ammonium nitrate.

There follows a series of some 30 fractional crystallization steps to produce 99.99% lanthanum ammonium nitrate.

After removal of lanthanum and cerium, remaining rare earths go to ion exchangers, joining the yttrium earths separated earlier.



BYPRODUCT trisodium phosphate crystallizes under vacuum at HM.



SEPARATION of TSP by continuous centrifugal precedes final drying.

▶**Caustic Attack**—Heavy Minerals starts its Chattanooga process with monazite ore ground dry in a conical mill. Water slurry of ground ore then reacts with NaOH at 255-305 F. over 4-hr. interval.

Addition of 1,250 gal. of water/ton of reaction mass dissolves trisodium phosphate (TSP) formed during caustic attack on monazite. Decantation separates TSP solution from rare earth-thorium hydroxide solids. Following filtration and crystallization, TSP is dewatered in continuous solid-bowl centrifugal and dried in rotary louvered dryer.

Thickened hydroxides of thorium and rare earths from the decantation step are filtered with a vacuum leaf filter which offers excellent washing and is easily accessible for observation and testing of product. Washing with dilute caustic and water lowers P_2O_5 content below 0.3% so that it will not interfere with thorium-rare earth separation.

Separate and Refine — Reslurrying and acidification with HCl to pH 3-4 dissolves the rare earth hydroxides but leaves solid thorium hydrate. Reaction is controlled to leave a small fraction of rare earths with the thorium to avoid any thorium contamination of the rare earth solution.

Filtration yields thorium fraction and high purity rare earth chloride solution. Rare earth chloride is processed in various ways to end products. Heavy Minerals has developed a preparatory method for concentrating and extracting europium.

Cerium is separated from the other rare earths by oxidation of cerium to a four-valent state and separation of 92-95% pure four-valent cerium by basicity. Other rare earths of commercial purity (90%) are prepared by methods involving crystallization and pH separation. Finally, HM prepares pure rare earth oxides by ion exchange techniques based on work by Dr. Spedding's group at Ames, Iowa.

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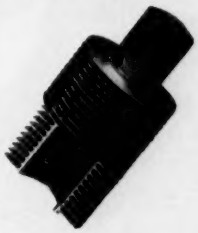

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DUPLEX PRIME SURFACE TUBE

U-BEND PALLETS

Duplex TYPE S/T

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Rare Earths Face 2 Challenges

1. Reduce costs for pure rare earths

High costs choke growth in conversion of plentiful ore to pure products.

2. Develop new uses for refined materials

Less expensive products will need new markets to realize potential growth.

Produce pure rare earths[1] cheaply and then find new applications for them: This is the two-fold problem now facing the rare earths industry. To achieve the first goal, companies in the field have under way extensive research programs to improve extraction technology, aimed mainly at solvent extraction. To reach the second objective, seven major firms[2] are co-sponsoring an extensive applications research program at Battelle Memorial Institute.

Far from "rare" as the name says, rare earths are in plentiful supply. Around 1,500 tons of rare earth materials are consumed annually in the U. S. while production capacity is around 10,000 tons/yr. Prices for these materials vary from $3/lb. for mixed rare earth metal (misch metal) to $2,000/lb. for pure lutetium, down considerably from a few years ago but still quite high.[3]

▶ **Vicious Circle** — This high price for pure rare earths has these elements on the familiar merry-go-round: Price can't come down until some volume uses develop, but no one wants to use them because of their high price.

In spite of this apparently gloomy situation, rare earths are viewed by many as our last great storehouse of unexploited materials—we have barely begun to explore their potential. With this in mind, companies are pushing vigorous research programs with a view to breaking this vicious circle; companies including old timers like Lindsay and comparative newcomers like Union Carbide Metals.

Aiding their cause are various government research programs which are being kept under close wraps. The Atomic Energy Commission is interested in the nuclear properties of several of the rare earth elements, while others are being investigated for space-age alloys.

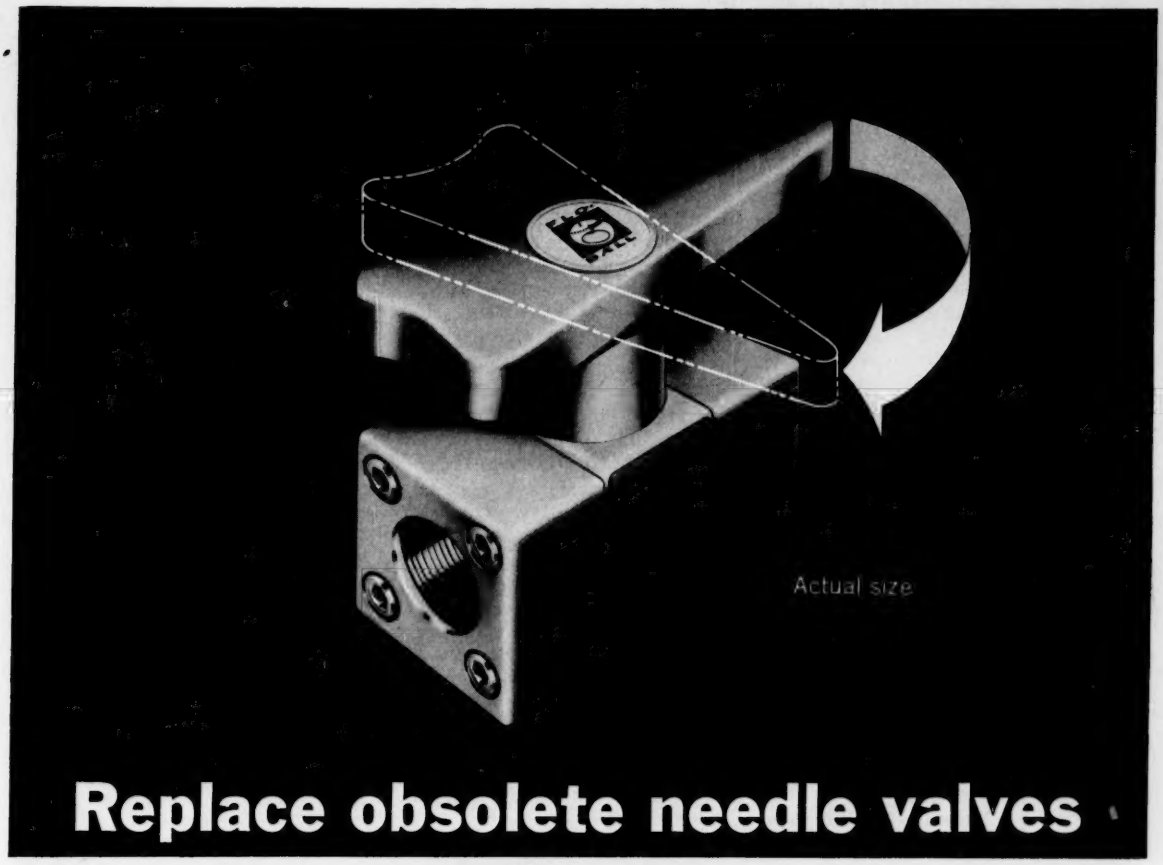
The dollars being spent on research today indicate that these companies expect a breakthrough in the not-too-distant future that will make rare earths truly commercial.

▶ **Heart of the Problem**—High price for these pure rare earths stems not from the fact that the ores are scarce and expensive, but rather from the fact that processes required to separate the element mixture in the ores are complex and require expensive reagents—coupled with the low volume of present production.

Pure rare earth compounds have the biggest growth potential—and present the biggest processing headaches. Most pure rare earths are produced today by ion exchange (pp. 104-107), but it takes several months for the mixed chloride solution to complete its journey through the ion exchange train. Besides being agonizingly slow, ion exchange involves expensive chemicals and high capital investment per ton of production.

Solvent extraction, a potentially much cheaper separation technique, is already being used on some of the "easier" separations. Davison Chemical at its Erwin, Tenn., nuclear fuels plant produces thorium by extraction with tributyl phosphate in its 40-ft. pulse columns (*Chem. Eng.*, Oct. 20, 1958, pp.

1. Term "rare earths" used in this discussion includes the lanthanons, elements 57 to 71, plus yttrium and thorium.
2. Davison Chemical, Union Carbide Metals, Heavy Minerals Co., Lindsay, Mallinckrodt, Michigan Chemical and Molybdenum Corp. of America.
3. Good background on rare earths is contained in "Where Are the Rare Earths Today?" in the June 1958 *Battelle Technical Review*.



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138-141). Lindsay produces pure cerium by solvent extraction, but cerium is one of the easiest to solvent extract, because of its unique quadrivalency.

▶ **Who's on First?**—It is difficult to pinpoint the thinking of the various companies on new processes because they all smell potentially big markets in the offing. Example: Heavy Minerals Co. has developed a new "chemical" process to produce pure europium, but no further details are available.

The Bureau of Mines is researching rare earths, too, and from what they tell *CE* it looks like solvent extraction will supplement rather than replace ion exchange. Solvent extraction can make rough cuts of rare earths cheaply and at high throughput, but Bumines hasn't been able to get high purity with this procedure (although work is still being actively carried on). Bumines feels now that ion exchange will be called on to perform final cleanup on solvent extraction cuts.

▶ **Sample Results**—At Bumines' Albany, Ore., station, researchers are extracting yttrium from euxenite, a mineral found in considerable quantities in Idaho. Using a tertiary amine diluted with hexone, workers have been able to extract yttrium from rare earth nitrates solution with 75% efficiency. Product purity is only 86%, however. (Bumines also has developed a process for making ductile yttrium, which has potential nuclear applications because of its unique corrosion properties.)

At its Reno, Nev., station, Bumines is carrying on a wide extraction research program, concentrating on tributyl phosphate and amine extractants. Present work is aimed at increasing extraction efficiency and boosting product purity along with developing improved extraction apparatus.

▶ **Where To?**—And where will pure rare earths find use? Battelle is hoping to find semiconductor applications for rare earths along with new catalysis uses, among others.

New alloys present intriguing possibilities. A magnesium-thorium alloy has been developed which makes it possible to use magnesium up to 600 F. Steel companies are investigating rare earths in stainless and other special alloys, but these companies, too, won't disclose exactly what they are exploring.

One thing seems sure: With so many companies spending so many dollars on rare earths research, we will see these elements finding much wider application in our technically expanding world.

Zimmerman Process Now Slated for Two Sites

Zimmerman process for sewage sludge disposal, after proving itself in year-long pilot-plant tests, has now received commercial endorsement from two corners: Metropolitan Sanitary District of Greater Chicago and the city of Wheeling, W. Va.

Process (*Chem. Eng.*, May 1957, pp. 150-152) involves pressurized wet oxidation of waste sludges with air, oxidation of inorganic wastes, oxidation and cracking of organic wastes.

Chicago's Sanitary District plant will have a capacity of 200 tons/day of sludge solids, will consist of four 50-ton-capacity units. Contract between CSD and Sterling Drug, designer and builder of the plant, amounts to nearly $11.9 million, calls for completion within 24 months.

Sterling's contract with Wheeling sanitary board calls for a 5-6-ton/day plant to be completed within 15 months.

New Process Upgrades Light Oil Fractions

Announced at the recent meeting of the American Petroleum Institute's Refining Division in New York was a commercially proved low-cost process for upgrading such light petroleum distillates as home heating and diesel fuels, gasoline, kerosine, jet fuels and solvents.

The new process, Nalfining, involves use of acetic anhydride to inactivate mercaptans, nitrogen and oxygen impurities, can be installed for an equipment investment of 50-75¢/bbl. of processing capacity. Processing costs vary with the stock treated and the amount of impurities: as low as 3 mils/bbl. for solvent deodorizing; as high as 3½-5¢/bbl. for sour streams of gasoline or light cycle oil.

Process, now being licensed by Nalco Chemical Co. (formerly National Aluminate Corp.), has been commercially tested at two Southwest refineries in units ranging from 1,000 bbl./day to 20,000 bbl./day.

Light fractions, after contacting anhydride, are given a caustic soda wash to remove reaction products (acetates; sulfur, nitrogen and oxygen products remain oil soluble and innocuous). Excess caustic is removed periodically and can be used for other treating processes. It's also possible to recover sodium acetate.

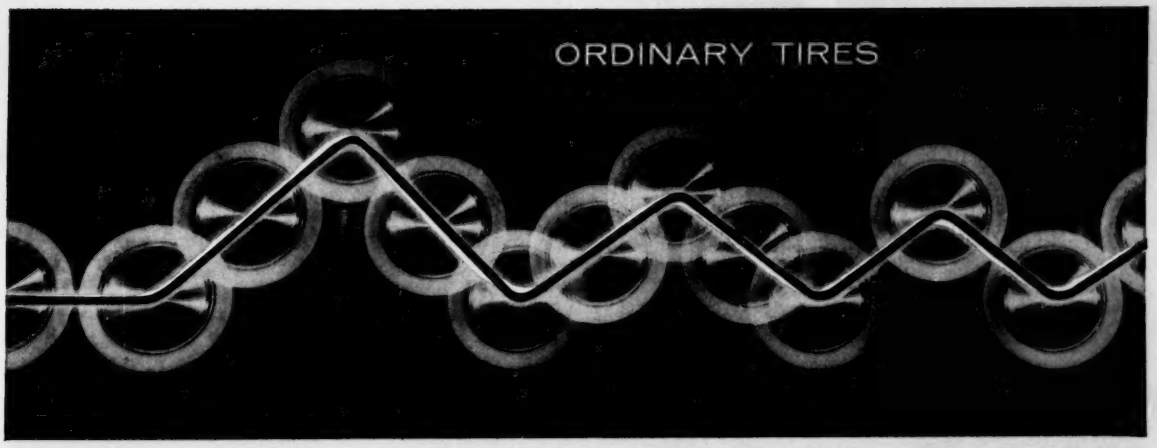
NEWS BRIEFS

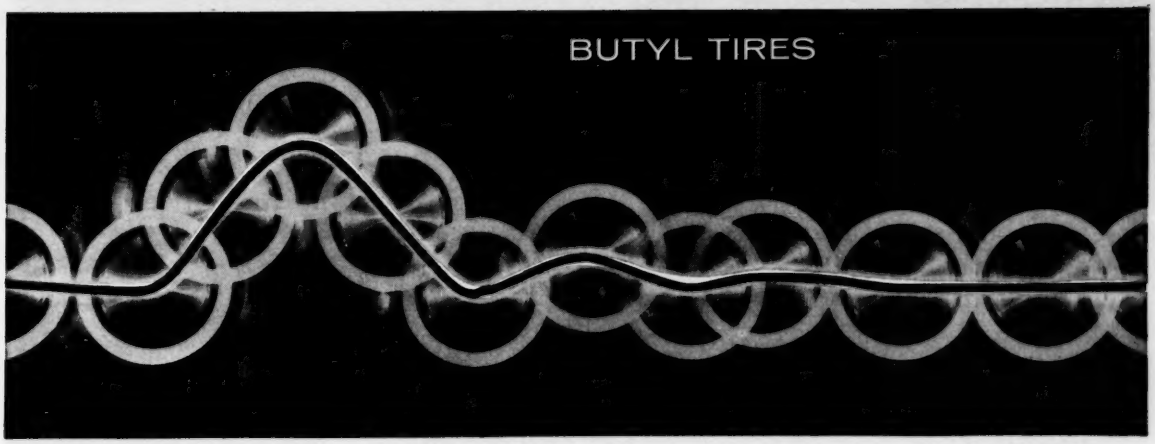
Atomic reactor fuel: Union Carbide Metals Co. has signed a contract with Atomic Energy Commission to study uranium carbide fuel clad with columbium. Such fuels could be used in 1,500-2,000 F. range, and they have better thermal conductivity and higher uranium atom density in molecule than UO_2.

Caprolactam: Thuebingen University research team, led by Eugen Mueller, has succeeded in producing caprolactam via cyclohexanone oxime hydrochloride. Latter is produced quickly and in yields of about 90% by irradiating cyclohexane-NO-Cl_2 mixture with 300-micron light source in presence of HCl.

Oil-water fuel: Soviet scientists recently proposed fueling locomotives and river boats with water-in-oil emulsions, reported that heavy oil emulsions containing 15-20% water actually proved 1-3% more efficient than conventional fuels in river boat operation. Emulsion is formed with the aid of compressed air.

(*Continued on p.* 70)





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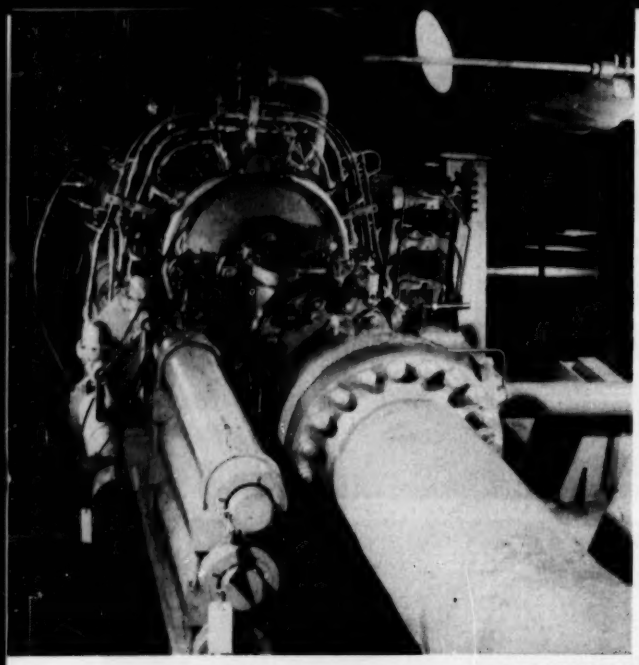

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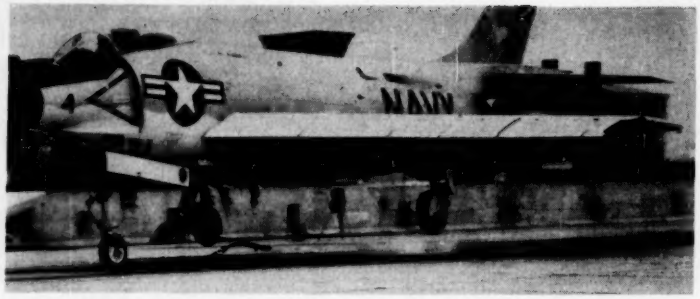


SUPERSONIC F3H Demon aircraft drops launching bridle at end of run.

Combuster Blast Hits New Power Peak

Power, in massive controlled amounts, comes from a beautifully engineered new generator that burns jet fuel in a rocket-type combustor. Coupled to a high-capacity catapult, this CP115 powerplant can deliver up to 70 million ft. lb. of energy. That's enough to increase launching capacity of present catapults 50% and to launch a 50-ton aircraft at 125 knots.

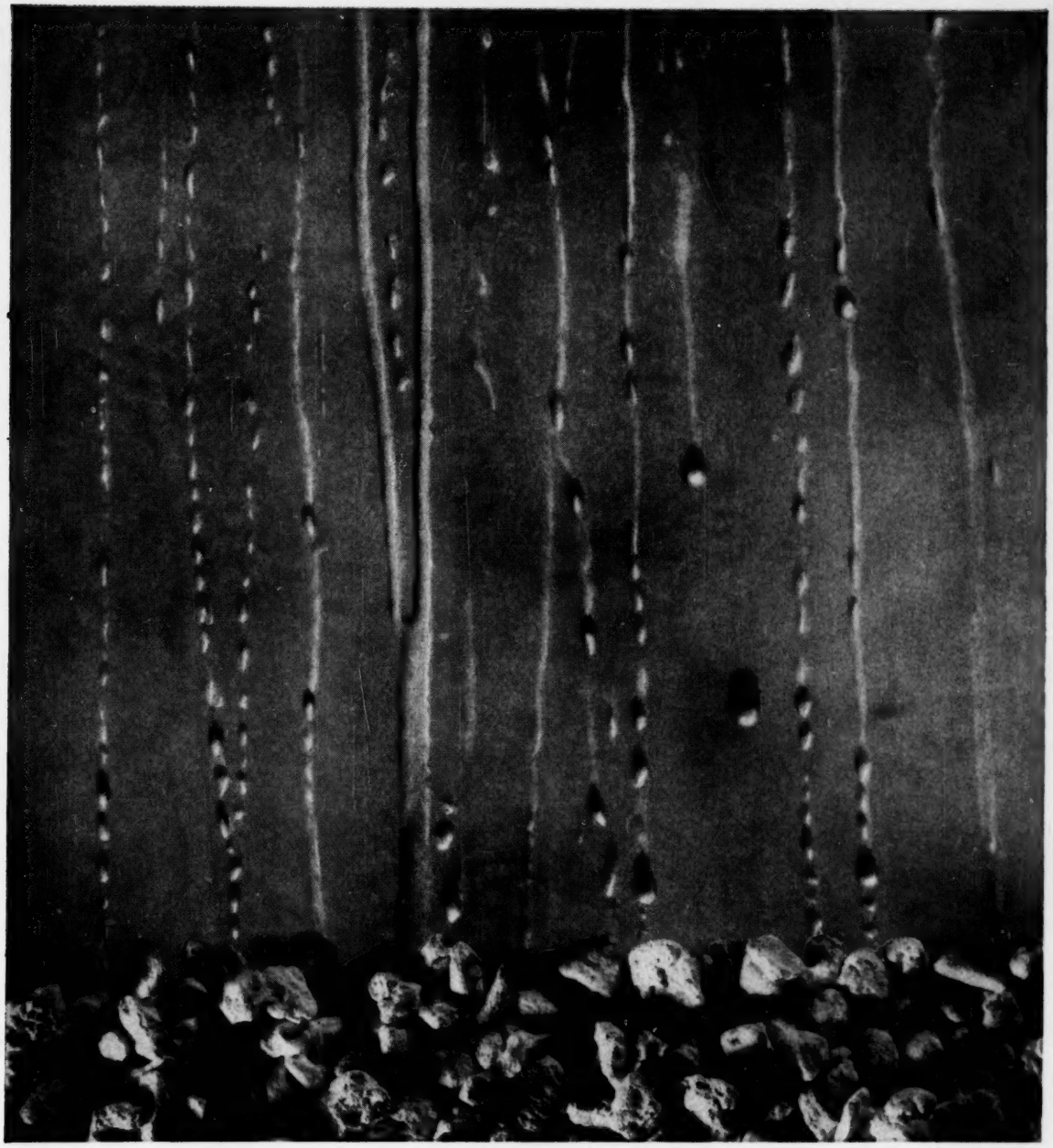
Late in May, engineers who developed the generator at Thiokol Chemical Corp.'s Reaction Motors Div. demonstrated its effectiveness with live launching trials at the Naval Air Test Facility, Lakehurst, N. J. In succession, system launched a 17,500-lb. F9F Cougar and a 27,500-lb. F3H Demon without a hitch (see above).

Four similar systems are now being built for installation aboard the Enterprise, first U.S. nuclear aircraft carrier now under construction.

▶ **Release Point**—Heart of the new system is combustor where energy is released by high-speed controlled combustion. Air from single accumulator at 1,500 psi. enters 22½-in. dia. combustor through 7.62-in. dia. ball valve and mixes with fuel entering through poppet valves spaced around combustor 18-24 in. downstream.

Air-fuel mixture passes through flameholder and burns to produce 2,500-F. gas. Some 5 ft. downstream water injection cools hot gas to 600 F. Mixture of combustion products and steam then drives pistons in launching tubes which are connected directly to aircraft being launched.

▶ **Feedback**—Flows of fuel, air and water are controlled by ball valves linked together mechanically to maintain proportioning. Servo system, actuated by pressure pickups a short distance down the launching tubes, regulates ball valves to maintain constant pressure in launching tubes throughout stroke.



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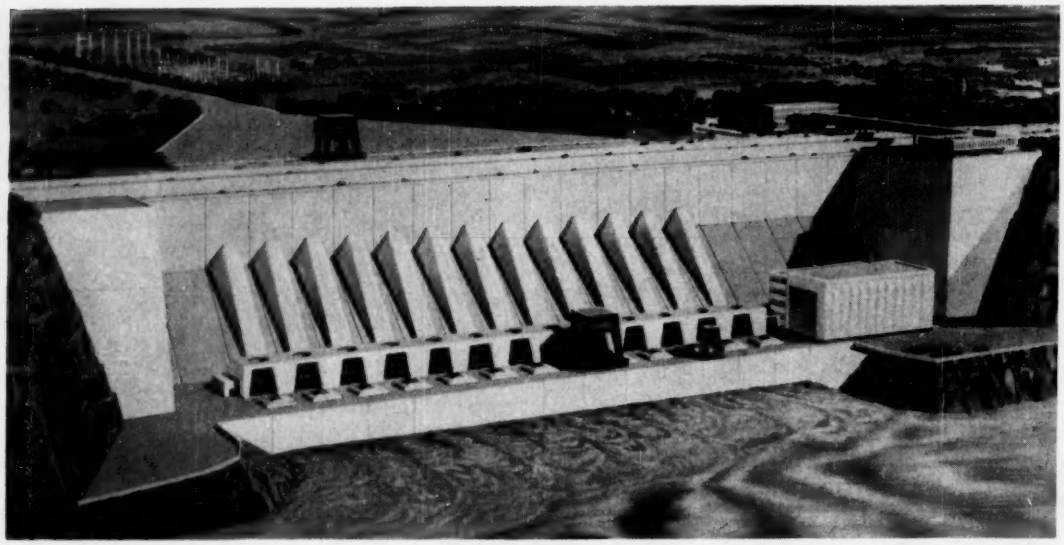


REJUVENATION of Niagara power is mirrored in this drawing of how Lewiston station will look in 1961.

Plenty of Niagara Power—for a Price

Hydro power is coming back to the Niagara Frontier. But it'll cost more to use, and there still won't be enough to go around.

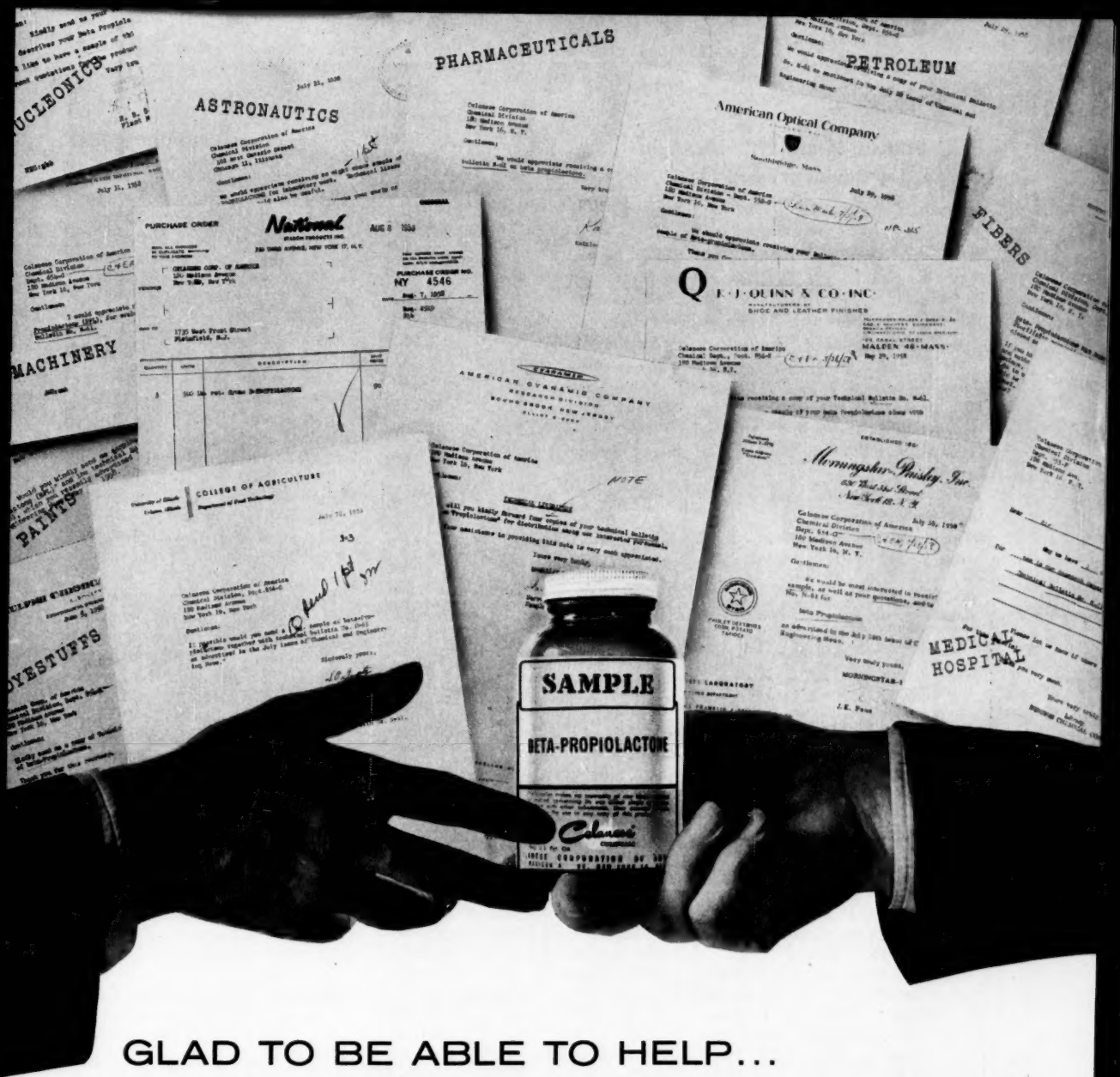
Roland A. Labine, Assistant Editor

After three years, the dust kicked up by the rockslide destruction of the Schoellkopf power station at Niagara Falls is beginning to settle. Chemical process engineers may not like everything they can see now but at least the picture is getting clearer.

This is how the situation looks viewed through the still-remaining haze: The Niagara redevelopment project, on which work is now at a peak, will restore cheap hydroelectric power to industry in that area—but there won't be enough for all who would like to use it, and it won't be as cheap as it used to be.

And this realization could be a portent of something even more serious and far-reaching. "The real problem," says a Niagara chemical engineer, "is how much Niagara Mohawk (the utility company on the Frontier) power must be added to insufficient redevelopment hydroelectric power to fill out our demand—and what will it finally cost? The combined bill, based on the average power costs, will determine whether conversion of 25-cycle power to 60-cycle power will pay off—or whether industry should locate new plants elsewhere."

▶**Setting It Straight**—Actually, there hasn't been enough "cheap" hydroelectric power on the Niagara Frontier for a long time. The loss of the power station in the 1956 rockslide fur-



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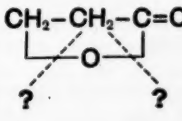

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How Process Firms Will Share in Niagara Redevelopment Power*

Niagara Falls Area	Power Allotment, Kw.
Union Carbide Metals	118,100
Hooker Chemical	44,500
Du Pont	36,700
Olin Mathieson Chemical	21,300
Union Carbide (National Carbon Div.)	18,200
Carborundum	18,100
Kimberley-Clark	11,500
International Paper	7,900
National Lead (Titanium Alloy Div.)	6,100
Great Lakes Carbon	5,300
Union Carbide Chemical	4,400
International Minerals & Chemicals	3,100

Buffalo and Other Areas	Power Allotment, Kw.
Stauffer Chemical†	6,300
Food Machinery & Chemical (Becco Div.)	5,000
Allied Chemical	2,900
Dunlop Tire & Rubber	2,300
Lehigh Portland Cement	2,500
Penn-Dixie Cement	1,600
International Paper	1,600
Du Pont	1,300
Hooker Chemical (Durez Plastics Div.)	1,000

*Nearly half a million kw. of 60-cycle hydroelectric power from the New York State power authority will be made available by Niagara Mohawk Power to Niagara Frontier firms when the power redevelopment program is completed. Power allotment for each firm in Niagara Falls is limited to 86% of 25-cycle power used prior to June 1956; elsewhere the limitation is 79%. To get this power allocation, each firm must have converted an equal amount of 25-cycle power to 60 cycles. †Stauffer's plant, although geographically located in the Niagara Falls area, will have the same contract as plants outside the area.

ther aggravated the shortage of hydroelectric energy.

Redevelopment will present a huge block of water power to electricity-hungry electrochemical and electrometallurgical producers — more, some say, than has ever been available before from the American side of the Niagara River.

But it will be 5-mill/kwh. water power, not 3-mill power, as before. And any thermal power needed to supplement this hydro power—and plenty will still be needed—will cost more than in the past, thanks to rate increases granted since the Schoellkopf disaster.

There's another catch, too: Industry must pay for the right to use this new power, in the form of capital outlays to convert 25-cycle facilities to 60-cycle service. (All redevelopment water power will be 60-cycle power.)

Of course, equipment conversion is more than just a "penalty payment." Much 25-cycle equipment on the Niagara Frontier is very old, albeit still useful—written off years ago and obsolete by today's standards in many instances. Thus, as one firm admits, "We would have had to modernize eventually anyway. This way we must replace equipment all at once instead of the day after tomorrow."

That rockslide mentioned above destroyed two-thirds of Niagara Mohawk's Schoellkopf hydroelectric station at Niagara Falls in 1956, knocking out the main source of 25-cycle power for the electrochemical and electrometallurgical industries — industries for which electricity is a major raw material. (Electric power can account for more than 30% of all raw material costs for some electrochemical firms.)

Since then, the industrial power setup at Niagara has been in a state of flux. Supply of 25-cycle power in the area has been supplemented in the interim by power from Canada—available at premium rates.

► **Capital Cost, Too**—And industry is currently engaged in a massive campaign (running well over $20 million, according to one estimate) to convert its facilities to accommodate the 60-cycle power forthcoming from the Niagara hydroelectric redevelopment being carried out by the Power Authority of the State of New York (SPA).

This $720 million redevelopment will again harness the waters of the Niagara River to turn out 1.7 million kw. of electricity. Yet less than half of this power, which will start coming from the project early in 1961, will be available to industry on the Niagara Frontier.

Two big blocks of hydroelectric power—all 60-cycle—will be offered to industry in 1961: 200,000 kw. from the SPA, allocated for plant expansion; and 445,000 kw., also from the SPA but which will be marketed by Niagara Mohawk Power. This latter block of power comes from the SPA as replacement for the company's loss of its Schoellkopf hydroelectric station.

Soon after SPA announced it was accepting applications for the 200,000 kw. of expansion power, events which will have far-reaching effect on the area's future began popping in rapid-fire order:

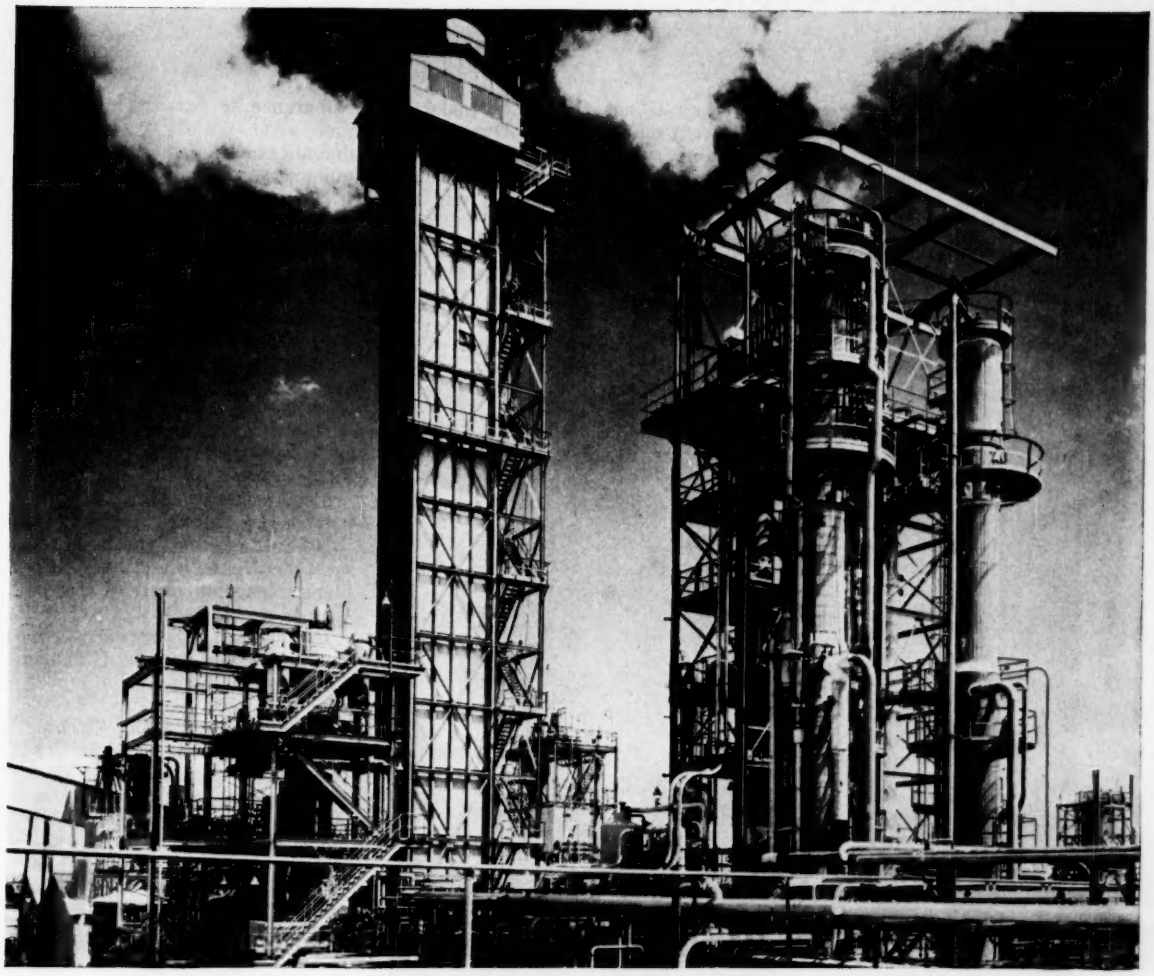
• Niagara Mohawk allocated its 445,000 kw. of replacement power for industry to 43 plants in the Niagara area, half of which are chemical processing firms (table, this page). Niagara Falls plants will get low-cost 60-cycle power equivalent to 86% of their 25-cycle demand prior to the Schoellkopf disaster. Plants in Buffalo and elsewhere will get only 79% replacement.

• Niagara Mohawk was granted a rate increase of 4-6% on power which it generates itself. (This increase has no effect on cost of power coming from SPA's Niagara redevelopment program.)

• New York's Governor Rockefeller, evidently concerned about the shortage of cheap power in the state, has appointed a commission to look into other possible sources of low-cost power, including nuclear energy.

► **How Cheap?**—Rates charged by the SPA for expansion power will be same as charged at the St. Lawrence Seaway project: a monthly capacity charge of $1 for each kilowatt of firm power and an energy charge of 2.67 mills/kwh. This figures out to slightly over 4 mills/kwh.

In addition, there will be a wheeling charge from Niagara



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The new license package also makes available for the first time a new ammonia recovery system—currently saving 10-15 tons a day for Grace, and a highly efficient purification system. For information write to: *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.*

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Mohawk, whose lines will be used to deliver the power, plus taxes and a load factor adjustment.

Rates charged by Niagara Mohawk for the 445,000 kw. of replacement power will be presumably the same as SPA rates for expansion power since the company is not allowed to make a profit on this power. One uncertainty: Niagara Mohawk's wheeling charge, as yet unannounced; one source estimates it will be about 0.75 mills/kwh.

▶ **No Agreement**—Industry comments on the situation vary from exuberance to extreme caution. Soon after the SPA allocation announcement, Olin Mathieson announced a $9-million expansion of its Niagara Falls caustic-chlorine plant and lauded the redevelopment project. Thomas Moffitt, president of Hooker Chemical, was quoted as saying he was pleased with SPA's plans, but added he was reserving final judgement until final allocations are made to individual companies.

Another spokesman says 60-cycle modernization will enable industry to build the most modern and productive chemical complex in the country. He hedged, though, on the question of whether there would be much plant expansion once all hydroelectric power is spoken for.

Union Carbide, conceded to be the bellwether of the Niagara Falls flock in the matter of power rates, is more cautious. President Intemann of Union Carbide Metals says he looks for an electric bill somewhat higher than before the Schoellkopf disaster. Asked if he still viewed the Niagara Frontier as a desirable location for further plant expansion, Intemann said he would have to wait and see what final over-all power rates are.

An engineer in another plant figures his plant power costs are going to go up around 35% compared to pre-Schoellkopf rates because of need to fill out demand with more expensive thermally generated power and the capital investment needed to convert 25-cycle facilities to 60-cycle service. He concludes his company will be best off transferring as much production as possible to another plant.

Some further contrasts: Stauffer Chemical announced in February that it was spending about $2 million to modernize and expand (25%) its Niagara Falls chlorine-caustic soda plant; but Carborundum, another Falls manufacturer, says the Niagara area "has been pricing itself out of the market."

Actually the cost of 60-cycle conversion depends on the type of power load each plant has. The electric furnace users, in general, have only to buy transformers and go to work. The electrochemical producers with

ROCKSLIDE smashed a power station into Niagara waters three years ago.

Timetable for Niagara Power: Rockslide and Redevelopment

June 1956: Schoellkopf hydroelectric station of Niagara Mohawk Power two-thirds destroyed by rockslide.

March 1957: Niagara Mohawk advises industry to convert to 60-cycle power by 1961.

August 1957: Congress authorizes New York State to redevelop hydroelectric power on Niagara Frontier. State Power Authority (SPA) plans 1.8-million-kw. project.

August 1957: SPA grants Niagara Mohawk first rate increase.

June 1958: Niagara Mohawk files for new rate increase; industry protests hike.

February 1959: Tuscarora Indians block SPA plans for big reservoir and force reduction of project goal to 1.7 million kw.

April 1959: SPA discloses allocation pattern for expansion power and replacement power.

May 1959: Niagara Mohawk allocates its 445,000 kw. of replacement power to industry—all 60 cycle.

May 1959: Niagara Mohawk gets rate increases ranging from 4–6%.

Present: Industry waits for SPA to act on expansion power allocation of 200,000 kw.

February 1961: First power scheduled to come from redevelopment project.

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large electrolytic cell loads find it nearly impossible to economically convert most types of rectifiers from one frequency usage to another. New equipment must be ordered—which means not only new rectifiers but new switchgear, transformers, and other auxiliaries.

▶ **Short Supply**—At this point, one thing seems sure: There is not going to be enough cheap hydroelectric power to go around. Companies will probably have to fill out a portion of their expansion requirements with relatively expensive (around 7 mills/kwh.) power from thermal generation plants.

A quick check of a few key companies indicates that demand for the 200,000 kw. of expansion power is going to outstrip the supply. SPA will not confirm this, will only say that it has received "several" applications for power "and is anticipating several more." Too, it seems apparent that SPA is not going to parcel out the whole 200,000 kw. to existing industry. Some will be reserved for attracting new companies to the area.

▶ **Who Gets What**—Who will get this expansion power? SPA has set up several criteria defining types of new plants that will qualify for a power allocation. But the key phrase lies buried in the body of the long allocation memorandum: "In all instances (SPA will) afford preference to applications from industry which will do the most to advance the economy of the state." In other words, power awards for expansion are left up to the discretion of SPA.

SPA is accepting applications now, but had not started to evaluate them at the time this issue went to press. When rulings start coming down, the future of the electrochemical industry in the area will be riding on the decisions.

Adding to the confusion is another block of 170,000 kw., set aside by law for Ohio and Pennsylvania communities. But it now looks as though it will not be economical to transmit this power to those areas. So this, too, may be delivered by Niagara Mohawk to the Frontier area for the SPA rate plus the wheeling charge. Industry is hoping that it will get a slice of this block of power, but nothing has yet been settled by SPA on allocation.

▶ **Future Potential** — How will redevelopment affect the Niagara Frontier? Best guess seems to be that it will help, but not cure, economic woes that have been besetting the area. Buffalo and Niagara Falls were hard hit by the recession and have been slow to recover—especially in the field of unemployment.

Too, industrial sales of electric power in the area have been decreasing over the past few years while industrial sales over the rest of the country have increased over 100%. New plants have not been locating there but have been picking other cheap-power areas of the nation.

Cause of this rests on the unique basis of cheap power on the Frontier — Niagara Falls. There is just so much power that can be tapped from the river. After this potential is exhausted, supplemental power must come from steam generation. This is a costly proposition since coal has to be hauled a considerable distance.

Thus, there was enough cheap hydroelectric power to attract and support nascent electrochemical and electrometallurgical industries in the Niagara area, but not enough to sustain their growth.

▶ **No Savior**—When the Niagara redevelopment project was undertaken, many in industry tended to look upon it as the coming of the millennium. But now that the rosy clouds are coalescing into an identifiable pattern, it looks like less than the paradise many had wished for.

The Niagara Frontier will still probably not be able to compete for new plant sites and plant expansions when electricity is a major cost. One engineer in a large Buffalo chemical plant grumbles: "We used to pay 4.5 mills/kwh. for 25-cycle power. We are now paying 6.5 mills and are spending $750,000 to convert our plant to take 60-cycle power when the 25-cycle juice is eliminated. And we still don't know for sure what our costs will be." And he adds, "You know, we can ship product from our West Coast plant to the Atlantic Seaboard as cheaply as we can deliver it from this plant."

The rate increase recently granted Niagara Mohawk will certainly not make the area any more attractive to companies looking for plant sites in low-cost power areas, or seeking to allocate production to established plants.

▶ **The Background** — In June 1956, the Schoellkopf hydroelectric station at Niagara Falls was two-thirds destroyed by a rockslide. To help fill immediate industrial needs for 25-cycle power, supplemental electricity was purchased from Canada—at rates running as high as 8 mills/kwh.

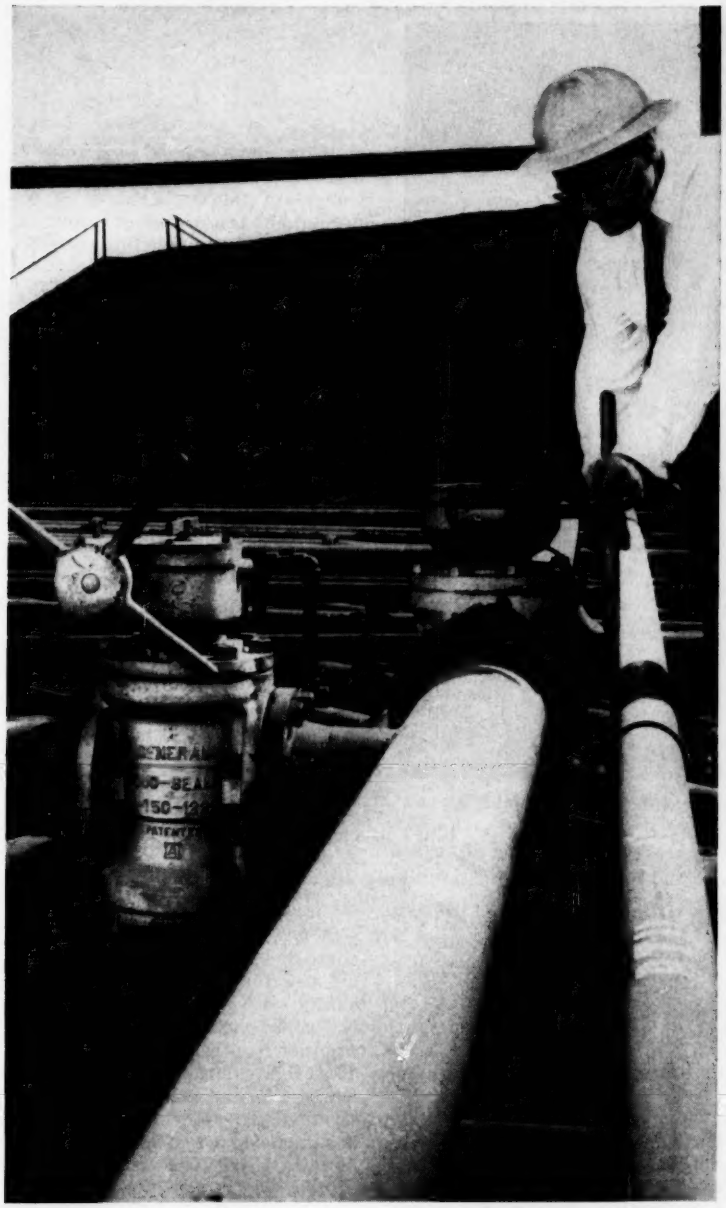
The rockslide also brought to a boil a controversy that had been simmering for years: Should New York State, Niagara Mohawk Power or the Federal Government have responsibility for developing the full power potential of the Falls? After much dickering, Congress gave New York State the right to proceed, with the proviso that 445,000 kw. would be turned over to Niagara Mohawk—in exchange for Niagara Mohawk's license to take water from the Niagara River—for its traditional customers.

Industry was then notified that, starting in 1961, the only cheap power would be 60-cycle power, requiring a changeover of 25-cycle facilities to take advantage of the new situation. This has meant investments varying from around $500,000, for some of the smaller plants, to $5 million for big consumers like Du Pont.

▶ **Rate Hassle**—Concurrent with the redevelopment project has been a bitter rate fight between Niagara Mohawk and industries in the area—most of which are represented by the Industrial Power Consumers Conference in Buffalo and the Basic Industries Power Committee in Niagara Falls.

Niagara Mohawk won a rate increase in August 1957, and not long after filed with the Public Service Commission for another rate hike. Industry groups hotly contested this bid for an increase —which was just granted in part. Friction generated by this rate fight has carried over to greatly aggravate the whole allocation problem.

Valve sealed with VITON® still gives positive shutoff after 1 year in benzene line



VITON synthetic rubber doesn't swell in the presence of benzene. In these valves at Richfield Oil Company, it has performed well for over a year. Cutaway photo of the valve, right, shows how VITON is used as O-ring and primary seat material.

Here you see a pair of General Duo-Seal Valves in benzene service at Richfield Oil Company's Wilmington, California, Refinery. For more than a year these valves have depended on reliable Du Pont VITON synthetic rubber parts to assure positive shutoff. VITON does not swell in the presence of benzene and other aromatics; it keeps its strength, shape and size—even at elevated temperatures.

Richfield is just one example. Other refineries have successfully used VITON-sealed valves for handling toluene, xylene and blends of these aromatics with other petroleum stocks . . . for 380° F. alkylate gas and for propane at temperatures as high as 400° F.

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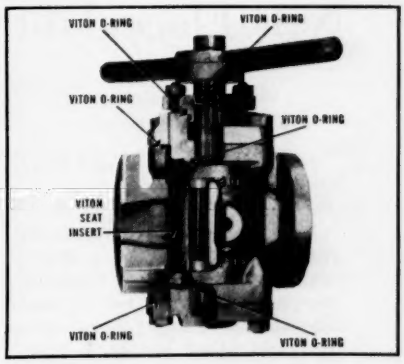

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Called Superfloc 16 flocculant, the product is a polyacrylamide. It aims particularly at competing with Cyanamid's own Aerofloc 3171 and Dow's widely used Separan NP-10, both of which are also polyacrylamides. With a molecular weight of several million Superfloc 16 is said to exceed the others on this score. High molecular weight is given a good part of the credit for performance superiority.

The product is particularly effective in thickening operations for increasing settling rates and overflow clarity. In settling acid-leached uranium ore at a countercurrent decantation plant, 0.006-0.07 lb. of Superfloc per ton of ore have provided the same settling rate, overflow clarity and underflow fluidity and density as 0.11 lb./ton of competitive product.

Other plant trials at Colorado plateau uranium operations, which also use countercurrent decantation for solid-liquid separation, have shown that Superfloc 16 decreases soluble uranium losses by increasing underflow densities 5-7%. Dosages of Cyanamid's new flocculant are the same as or less than those of Separan.

Cyanamid backs its faith in Superfloc superiority by setting its price at $1.50-$1.55. Competing products sell at about $1.10.—**American Cyanamid Co., New York.** 80A

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Fabric's suitability for this job is said to be based on a combination of good mechanical strength, flex life, resistance to chemical attack, ability to withstand continuous exposure to saline water.—**Union Carbide Chemicals Co., New York.** **82A**

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A-827-B is an opaque, cream-colored, medium viscosity, solvent type solution adhesive. Solvent is methyl ethyl ketone.

It is suggested for applications where polystyrene pellets are to be fused in place to base material such as steel, aluminum, wood, Masonite, Transite or Formica. The adhesive is first applied to the base material and thoroughly dried. The polystyrene pellets are added and fused in place.

Allowing the adhesive to dry before coming in contact with the polystyrene prevents any stress-crazing which might otherwise develop due to solvent contact.

A-827-B results in higher strength bonds than R-1083-T. However, because of the stress-crazing effect the former's solvent has on polystyrene, it is limited to applications where the polystyrene pellets are to be fused in place.

R-1083-T is a pink, medium viscosity, solvent type solution. Solvent is unleaded gasoline. It is suggested for bonding both polystyrene pellets fused in place to polystyrene sheet or prefoamed polystyrene to materials such as steel, aluminum, wood, Masonite, Transite, Formica or polystyrene sheet.—**B. F. Goodrich Co., Akron.** **82B**

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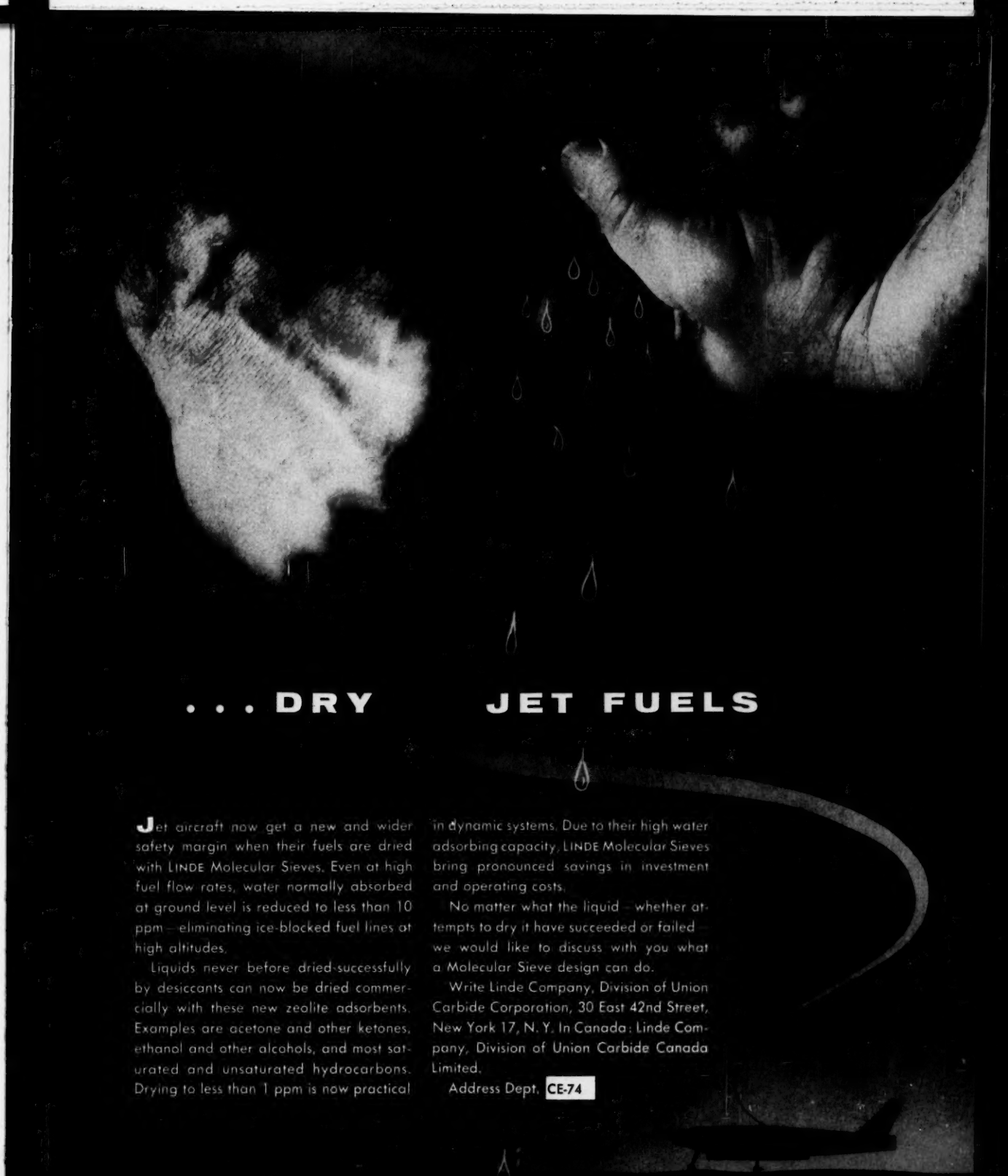

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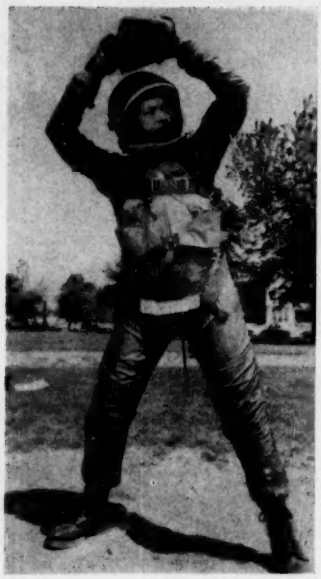

As Moon Man Evolves, His Mobility Increases

The Mark IV suit shown at right above was developed by B. F. Goodrich and the Navy to protect man in space. Flexible and light in weight (20 lb.), it has recently been adopted by the Navy for operational use in aircraft above 45,000 ft.

Suit's mobility is remarkable beside the rigidity of its predecessors: Left, the first space suit, dreamed up in 1934 by Wiley Post, was made of heavy rubberized cloth and featured a diver's helmet. Center, a Goodrich-Navy developed suit introduced in 1952 improved by means of airtight bearings and joints allowing some neck and shoulder movement, an automatic pressure equalizing controller, a Plexiglas helmet.

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Cyuram DS ultra accelerators. — **American Cyanamid Co., Bound Brook, N. Y. 82C**

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postcard (p. 191)

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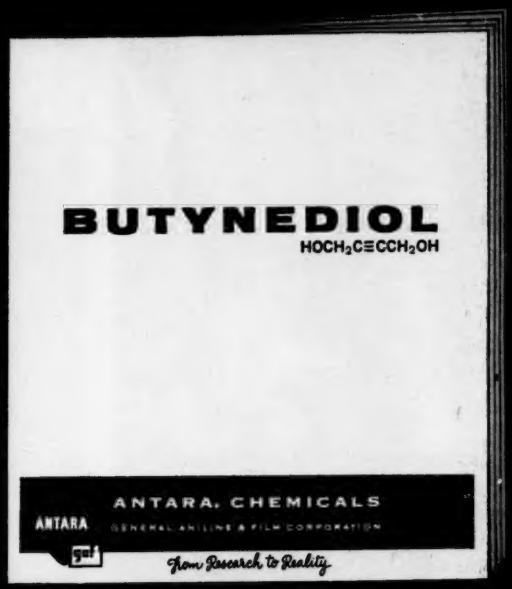
$HOCH_2C{\equiv}CCH_2OH$



Butynediol, a product of GAF's high-pressure acetylene chemical plant, has multiple centers of activity that open new synthetic routes to previously inaccessible compounds. It reacts as a glycol **and** a disubstituted acetylene. By trimerization, dimerization, and esterification, it forms cyclic compounds.

If you are interested in the development of agricultural chemicals, pharmaceuticals, electroplating chemicals, textile auxiliaries, or high energy propellents, Butynediol can be of great importance to you.

We have just printed a 44-page bulletin that describes Butynediol's physical properties, storage and handling, chemical properties and uses. You will find it full of the kind of information that stimulates new ideas. Write for it today.

From Research to Reality

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ANTARA® CHEMICALS

GENERAL ANILINE & FILM CORPORATION

Emperor Caligula Insisted on Quality Valves

Ancient Romans built their pipes, valves and fittings according to modern ASA and ASTM standards! This is the conclusion reached by Mario Fera (above, right), senior engineer for the Italian engineering firm, Compagnia Tecnica Industrie Petroli, S.P.A., of Rome, exhibiting in New York at last month's Fifth World Petroleum Congress.

According to Dr. Fera, an 80-lb. valve salvaged from one of Emperor Caligula's yachts (replica shown above) 's made of a zinc-free, lead-rich, anticorrosion, antifriction tin bronze. This metal has a composition very similar to ASTM B-144-3D cast acid metal and ASTM B-144-3E antifriction bronze. The Caligula valve was found submerged at the bottom of Lake Nemi in Rome. Although 19 centuries old, it still exhibits highly polished surfaces and retains its plug tightly.

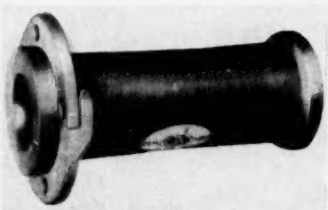
Other valves found in and about Rome and Naples are equally well preserved, Dr. Fera said. One found at a reservoir in a Roman villa was used regularly until three years ago by the peasants whenever they required water for irrigation. In 1956, it was decided that the cost of the valve had been amortized, and it was replaced after 20 centuries of service.

Agitating Device

Breaks agglomerates in conical vacuum dryer.

Conagrator, a new agitating device designed for Patterson Conaform vacuum dryers, breaks up agglomerative ingredients quickly, thus allowing uniform drying with high heat-transfer rates. This permits the processing of materials previously considered impossible to vacuum-dry effectively.

Each agitator is composed of drive elements and four intermeshing stainless steel blades. Mounted in one of the apexes of the conical dryer, the Conagrator is driven, when required, by a constant-speed motor. It does not interfere with normal operation of the dryer.—**The Patterson Foundry & Machine Co., East Liverpool, Ohio** 86A



Flexible Rubber Pipe

Designed to form a tight seal without gaskets.

According to company officials, the new Type G Gen-Lok line of flexible rubber pipe takes advantage of a superior method for mating and sealing of pipe faces. The single-piece, leakproof tube and multi-ply, wire-reinforced body comes furnished with new integral flanges made of resilient rubber. These are smooth-finished to form a tight, perfect seal against the

pipe flanges. In bolting, the rubber flange acts as its own gasket as it is compressed to form the seal.

Type G series is now available in all standard diameters from 1 to 12 in. I.D., and in any standard face-to-face length. Maximum working pressures are either 150 or 250 psig. The pipe can also be used for vacuum service.—**General Rubber Corp., Tenafly, N. J.** 86B

Plastic Tower Internals

Low-cost components meet rigid design demands.

Bubble caps and risers constructed of a thermosetting plastic material known as Wyatt's 1099 are now in production in sizes as large as 8 in. O.D.

In tests, this hardware was subjected to such harsh conditions as 10 months' service contacting 55 to 65% sulfuric acid at an operating temperature of 340 F.

One advantage of molded parts for tower internals is lower cost. A second advantage is that molding techniques permit design engineers to gain exactly what their processes demand.

Although present production is restricted to caps and risers, the company plans to extend its output to include trays, downcomers and all of the other assemblies required for distillation and treating equipment.—**Wyatt's Plastics, Inc., Houston, Tex.** 88A

Flexible Gear Coupling

Takes more misalignment than standard couplings.

A lightweight, nonlubricated, flangeless, flexible gear coupling with a one-piece nylon sleeve is capable of operating over a wide temperature range at speeds up to 5,000 rpm. Called Nyflex, the coupling is presently available in a selection of ten bore sizes ranging from $\frac{7}{16}$ to $1\frac{5}{8}$ in.

One of the unit's outstanding features is its ability to take nearly 5 deg. of misalignment. The coupling will absorb both angular and parallel misalignment as well as end float, with a minimum of backlash. Prices are as low as one-half that of comparable steel couplings.—**Sier-Bath Gear & Pump Co. Inc., North Bergan, N. J.** 88B

Combustion Safeguard

Continuously supervises gas-fired burners.

Known as the Protectofier, a new combustion safeguard control continuously supervises gas-operated burners. The control prevents fires or explosions caused by buildup of combustible fuel mixtures in either single or multiburner service.

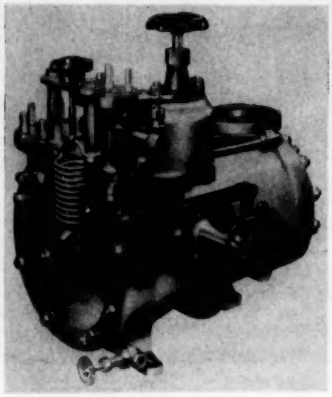
New design features include much greater compactness and reduced over-all costs. Entire electronic circuitry for each burner is contained in a single plug-in subassembly. If a flame failure or fault occurs at any burner position, the signal from the flame electrode is interrupted. This immediately breaks the circuit to the safety shutoff valve, thus stopping fuel flow to all burners in the system. Special flame cable is not required.—**Protection Controls Inc., Chicago, Ill.** 88C

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p. 191)



Turbine Pump

Medium-capacity unit for high-pressure service.

Newest addition to the line of Coffin steam turbo pumps is the Type IND unit. This pump is specifically designed for general industrial boiler feed service where medium volume and high pressure are required. The compact unit is complete with controls for constant or differential pressure regulation.

IND pumps are of simple, single-stage design, with turbine, pump and control in one integral matched unit. Capacities vary to 180 gpm.; discharge pressures to 350 psi.—**Coffin Turbo Pump Co., Englewood, N. J.** 88D

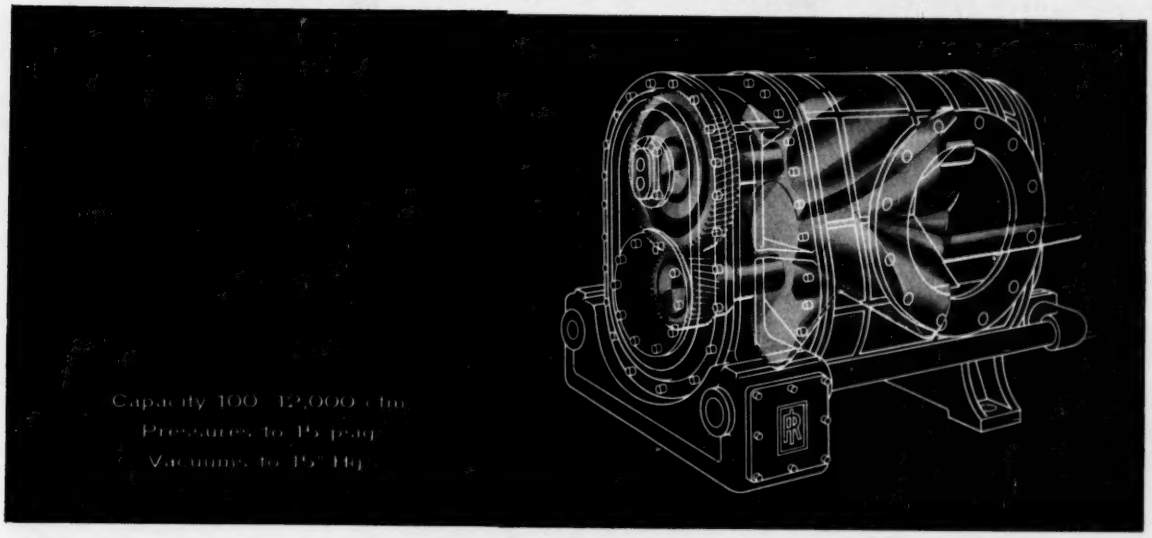
Metering Pump

Comes with a choice of materials of construction.

For metering clear and corrosive liquids to chemical processes, Milton Roy Co. offers the

IN A CLASS BY ITSELF...

the IR Axi-compressor



BECAUSE of its unique rotary design, the Ingersoll-Rand *Axi-compressor* delivers air or gas with less power in a smaller space than other types of compressor of equivalent capacity. It is equally suitable for pressure, vacuum or combination operation.

Utilizing the axial flow, positive displacement principle, the Axi-compressor discharges air smoothly and continuously, free from shocks. There are no pistons or valves, and the only moving parts are two perfectly balanced helical rotors which operate with minimum noise or vibration. The rotors never touch each other or the casing. Hence there's no need for internal lubrication.

Advantages:

- **Space-Saving, Compact Design** – can be installed on simple, low-cost foundations.
- **Clean, Oil-Free Air** – no danger of contamination from lubricants.
- **Smooth, Pulsation-Free Compression** – no bulky air receivers required.
- **Operates at Higher Motor Speeds** – can be direct driven without belts or gears.

Ask your Ingersoll-Rand representative for complete information. Or send today for a copy of Bulletin 11,001A.

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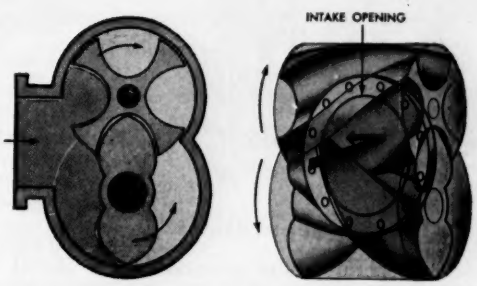
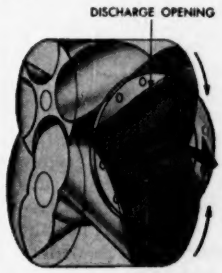
HERE'S HOW IT WORKS...



Intake: During the inlet cycle rotors are turning away from each other, drawing air or gas into the inlet space. This gas is then moved around to the discharge side of the compressor.

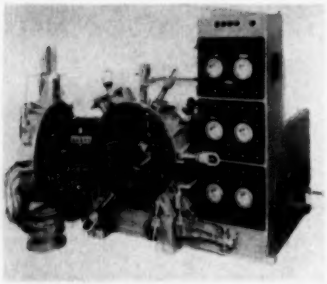


Compression and Discharge: During the discharge cycle the rotors are turning toward each other. They displace the inlet volume and air is smoothly compressed and forced axially toward the discharge opening.

PUMPS • CENTRIFUGAL & RECIPROCATING COMPRESSORS • DIESEL ENGINES • AIR & ELECTRIC TOOLS • TURBO BLOWERS • STEAM CONDENSERS

new Model CN controlled-volume pump. The pump delivers maximum capacities to 28 gph. in simplex design, and double that gallonage in duplex designs (two liquid ends with a common motor and base). Working pressures can vary to 1,100 psi.

Model CN features simplified construction for ease of operation and maintenance. Plungers are interchangeable within the pump frame, and models are easily converted in the field from simplex to duplex. Adjustment of the plunger's stroke while the pump is stopped regulates capacity. Standard drive is a ½-hp., constant-speed motor through a right-angle gear reducer. Materials of construction include steel, 316 stainless steel and Milroy stainless steel. **—Milton Roy Co., Philadelphia, Pa.** 88E

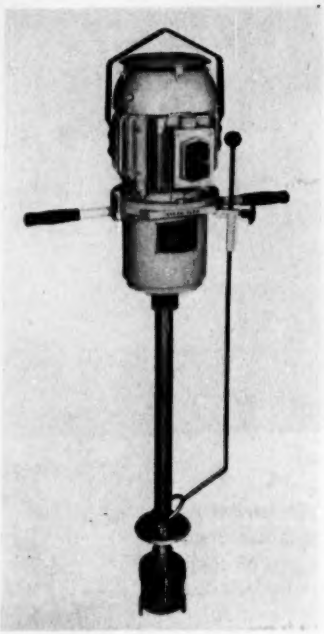


Continuous Separator

Can operate under internal pressures to 50 psi.

Designed and constructed of special steel to operate at 50 psi. internal pressure, a new, continuous centrifugal separator has an 18-in. dia. basket that automatically charges and discharges. Powered by a 15-hp. motor, the separator also features an automatic leveling device for the cake. Another construction feature is an arrangement that isolates the mechanical seal of the shaft so that it is not deflected with deflections of the housing.

Particularly suitable for separation processes at about −30 F., the machine employs "Ter Meer" principles of centrifuging, and has an automatically controlled system for pressurizing and depressurizing. According to the manufacturer, the unit is a forerunner of other sizes for special applications.— **Chemical Machinery Div., Baker Perkins, Saginaw, Mich.** 90A

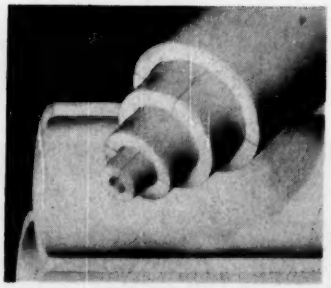


Industrial Mixer

Redesigned unit can be powered by many motors.

Completely redesigned, the new Model RL Shear-Flow industrial mixer provides a means for fast and thorough dispersing, blending and homogenizing. The unit's mixing head consists of two rotating impellers and two stationary stators enclosed within a cylindrical housing. Fine clearance between impellers and stators results in a more complete reduction of agglomerates.

Motors ranging from 2 to 10 hp., depending on the requirements of the application, will power the new Model RL. Motor and mixing-head changes can be completed in a few minutes on the spot. All parts subject to immersion are fabricated of stainless steel and corrosion-resistant materials.—**Gabb Special Products, Inc., Windsor Locks, Conn.** 90B



Pipe Insulation

For temperatures ranging from −300 to 220 F.

New urethane-foam pipe insulation called U-200 is especially suited for use at temperatures ranging from −300 to 220 F. U-200 is a closed-cell (85%) synthetic with excellent heat and chemical resistance; it will not burn.

Thermal conductivity tests have shown U-200 to have a *k*-factor of 0.14 at 70 F. mean temperature. The new material can be cut and applied with standard tools, and is nontoxic and nonirritating. It is available in accurate half-round sections of nominal thicknesses in standard pipe sizes. Individual sections are 36 in. long.—**Union Asbestos & Rubber Co., Bloomington, Ill.** 90C

Optimal Controller

Holds control for zero slope of process curve.

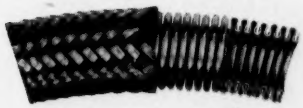
Latest addition to the manufacturer's optimal-mode controllers is the Maximizer, Model 760-W. While original models of the line hold control at any slope on the process curve, Model 760-W controls only for zero slope, a choice of a maximum or a minimum. (See *Chem. Eng.*, Feb. 1957, p. 192.)

Maximizing control mode forms the basis of a much simplified type of computer control.

EQUIPMENT NEWS
Continues on ..... Page 170

Whatever your problem in flexible hose connections,

call the Man from Anaconda Metal Hose

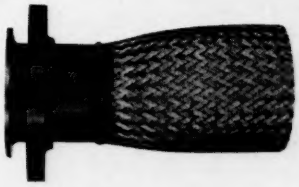


Seamless: Of tin bronze (98¾% copper, 1¼% tin)—also corrugated stainless steel—in sizes ⅛" through 4" I.D. For conveying fluids, chemicals, etc., under conditions of flexure or vibration and to allow for misalignment. Reusable (mechanical type), soldered or welded fittings.

Stripwound: Constructed from brass, bronze, aluminum, galvanized or stainless steel. Sizes ½" through 8" I.D. A rugged type of hose for general service as steam, oil, water, particularly where the hose is handled manually. Fittings: soldered or heatproof (packed-on).

Type UI: Interlocked unpacked hose in galvanized steel, stainless steel, aluminum, etc. Sizes through 8" I.D. For ventilating ducts, dust collection, engine exhausts, exhausts at grinding machines, bottle chutes, drain lines, protective casing for flexible hose assemblies.

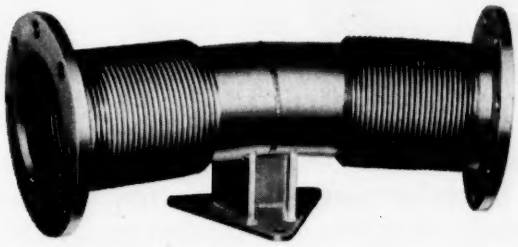
Diesel: Heavy-duty steel exhaust and air intake hose. Sizes 2" through 16" I.D. Designed for rugged, heavy-duty use. Helical corrugations with open or closed pitch. Also in stainless steel (type Y-21) for corrosive applications.



Fluxpipe: Takes up travel in piping, connects misaligned ports, dampens noise and vibration in piping. Standard sizes and lengths. Available in bronze, stainless steel, steel; in sizes ¼" through 16" I.D. with NPT fittings, flanges or welding nipples.

Teflon* Anaconda flexible connectors of Teflon with stainless steel wire braid for use with pipe sizes from ⅛" through 1¼". Available in a wide variety of standard hose assemblies complete with fittings.

*Teflon is a DuPont trademark for its fluorocarbon resins.

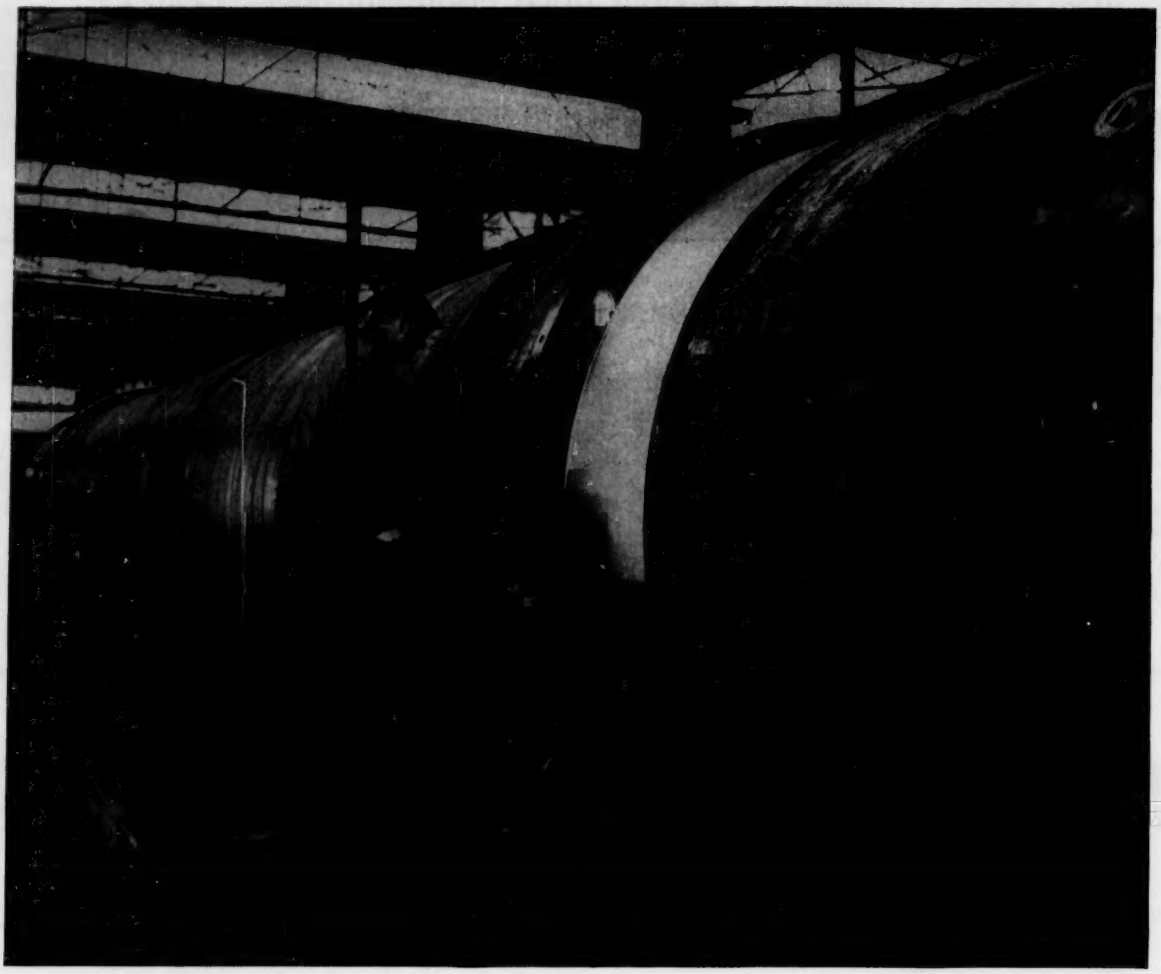


AX Tubing: Large diameter tubing for big, tough jobs. Available in Type 321 Stainless Steel, and other metals and alloys. Sizes from 4½" through 14" I.D. Designed to handle axial and lateral movement—while conveying large volumes of liquids or gases—for bulkhead seals, etc.

FREE TECHNICAL SERVICE. Anaconda Metal Hose specialists are constantly working with design engineers on special flexible connectors and hose to meet new problems. Having broad experience working in stainless steel, other steel alloys, Monel, copper alloys, aluminum, and Teflon, they can save you considerable time and money in designing the flexible connector best suited for any of your jobs.

Our specialists are available to you through Anaconda Metal Hose representatives in leading cities—see listing "Metal Hose" in the Yellow Pages. Or write: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Conn.

ANACONDA® METAL HOSE



Louisville Dryer—10 feet in diameter, 10 stories long!

Turn a ten story building on its side, and there'd be room to spare on either end of this huge pit lathe at Sharon, Pennsylvania where this 10′ x 110′ Louisville Dryer was fabricated.

This lathe is used for machining the reinforcing bands onto which are mounted the forged steel tires. This careful workmanship assures concentricity of the completed dryer shell—a primary factor in efficient seal operation.

Every Louisville Dryer is especially designed, manufactured, assembled and installed for its specific task.

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Louisville Dryers

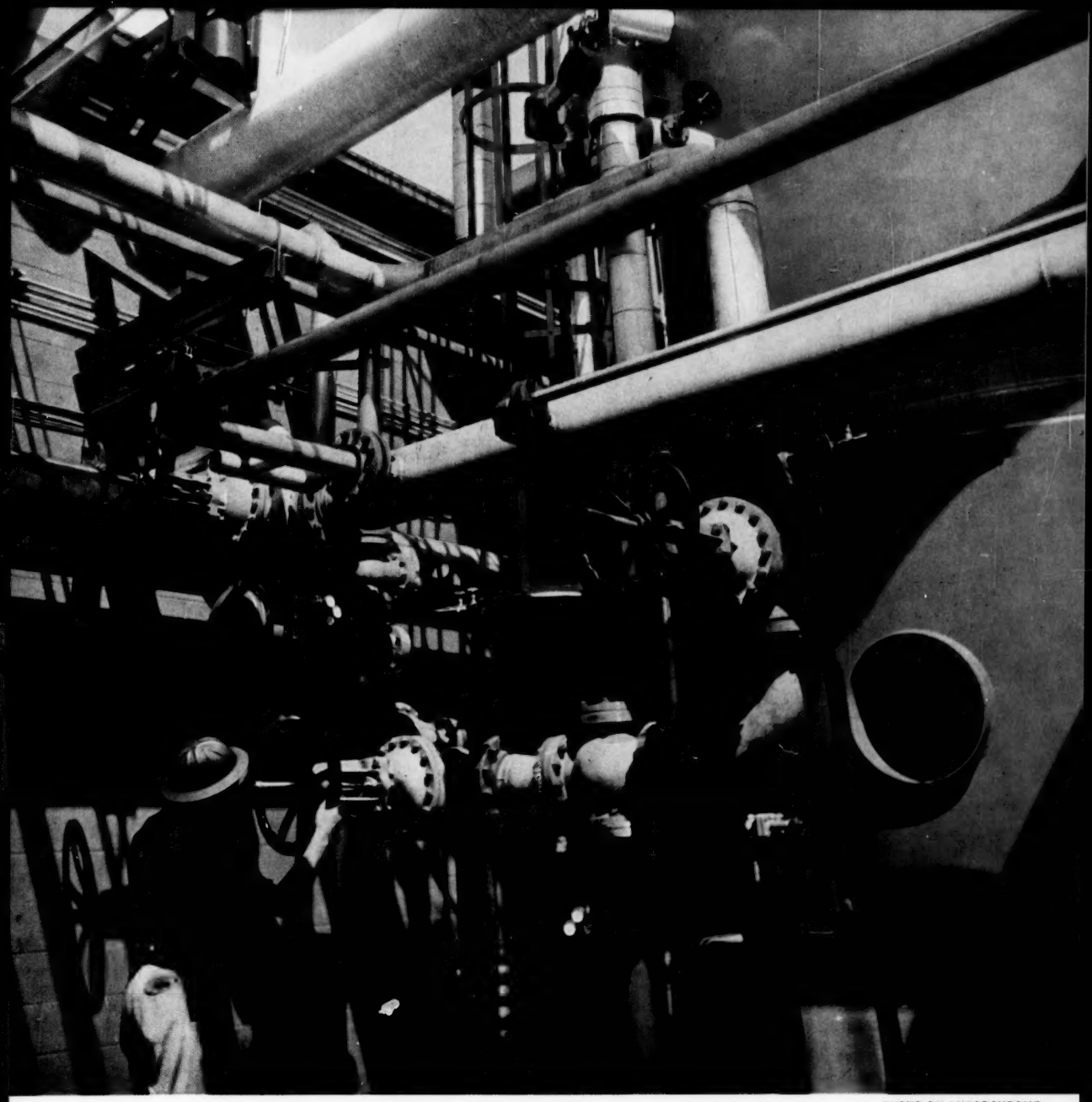

PHOTO ON ANSCOCHROME

SPECIAL PROCESS...General Aniline & Film Corporation's new plant at Linden, N. J., went on stream last year. Built by Scientific Design Co., Inc., it produces ethylene oxide by direct air oxidation of ethylene, Scientific Design's own efficient and economical process. The Aloyco Stainless Steel Valves here (red hand wheels) were selected for their design features and long life expectancy. On your next stainless steel valve job, why don't you talk first to the one company which specializes in high alloy valves exclusively. For further details about Aloyco Valves, write us at 1301 West Elizabeth Avenue, Linden, New Jersey. 9.5

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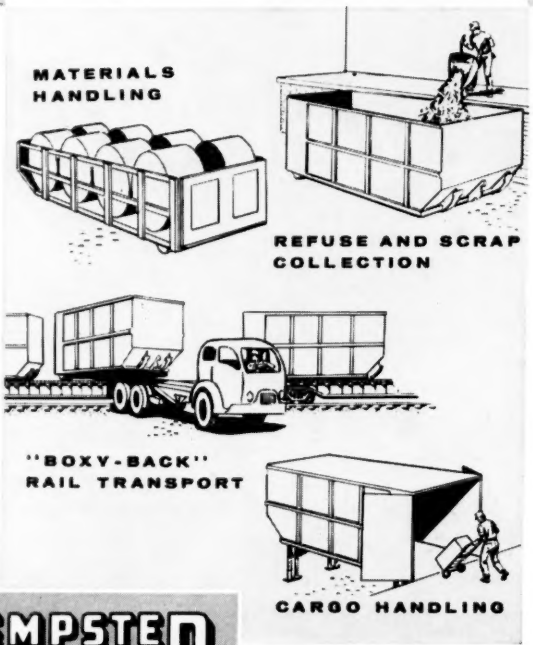

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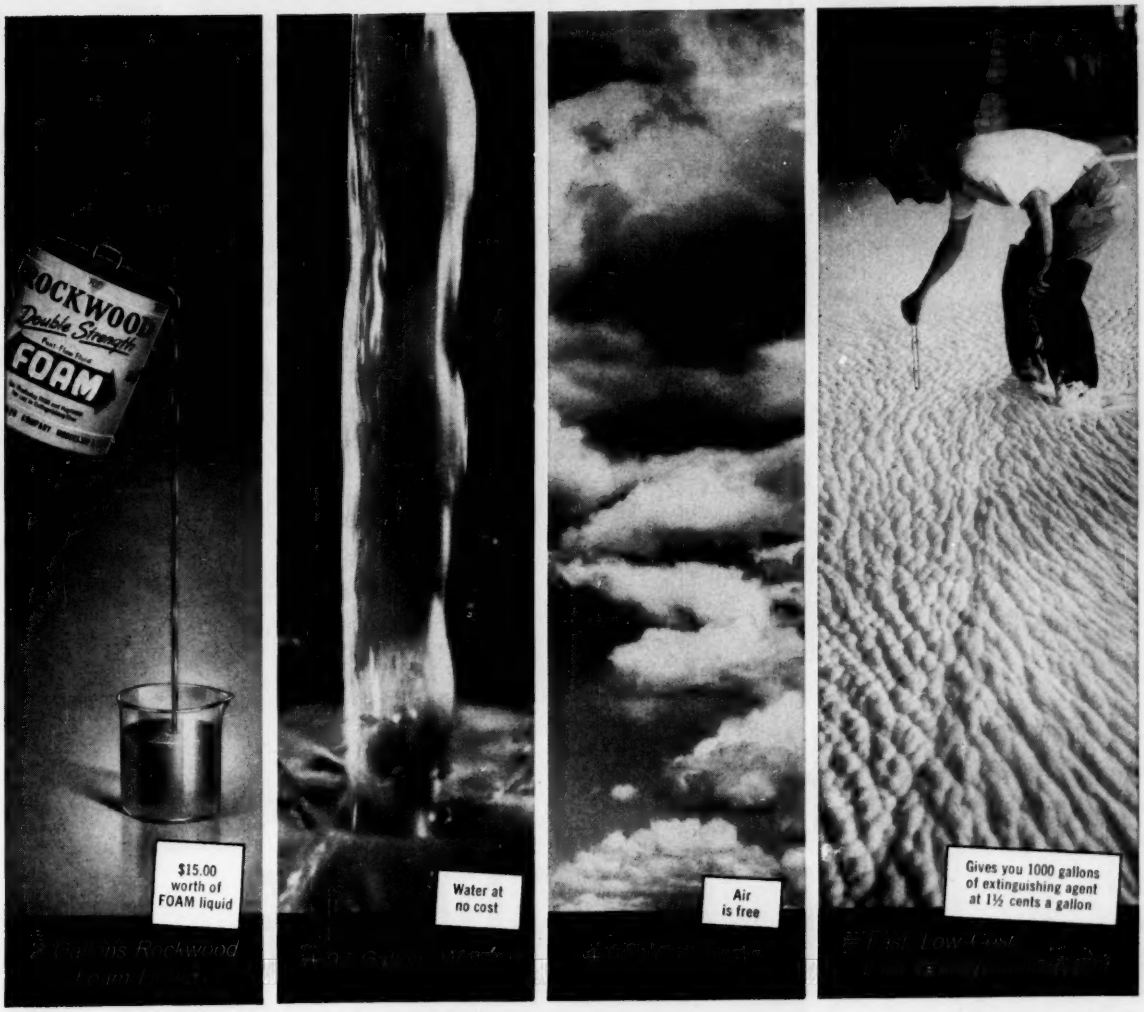
Rockwood Double Strength FOAM Adds Up to SAVINGS



Rockwood Double Strength FOAM liquid binds large volumes of air and water into the fastest, most effective, lowest cost extinguishing agent for fighting any type of fire.

Besides helping you save lives and property, it can save you hundreds, even thousands of dollars in the cost of fire-fighting material. Using other types of fire extinguishing agents, you pay 100% for the agent, plus storage and shipping. *Rockwood FOAM liquid costs only 3 tenths of 1% — shipping costs are less — storage costs are greatly reduced!*

Also, the very small proportion of Rockwood FOAM required enables you to use the extinguishing agent — actual, not simulated — for efficient departmental training, at negligible cost. Tested and listed by Underwriters' Laboratories, Inc. Send coupon for complete information.

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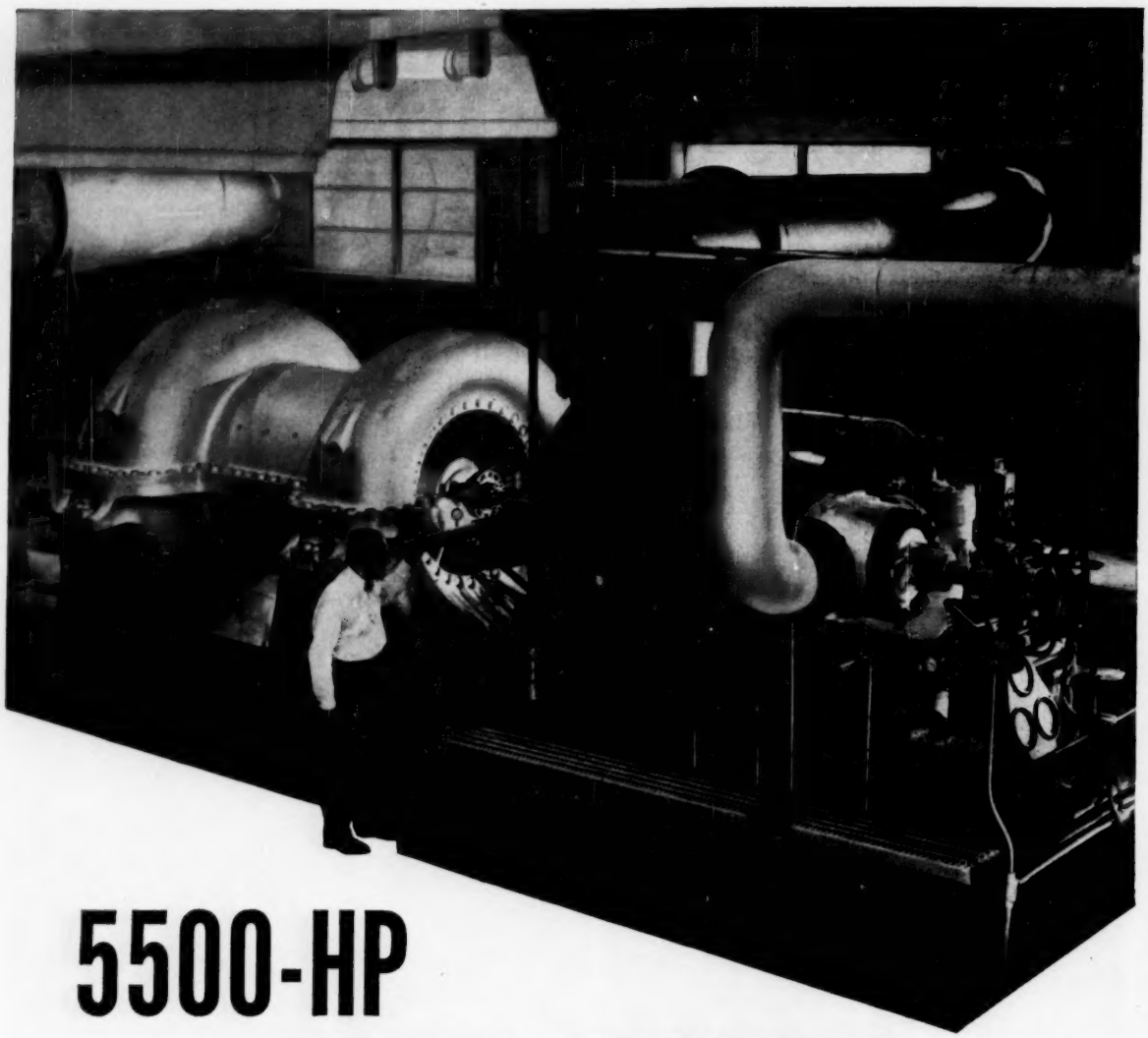

5500-HP TERRY TURBINE

plays an important role in compressor testing at Joy

Joy Manufacturing Company puts Terry high-speed turbine reliability to good use in its development facility at Buffalo, New York. This 5500-hp multistage turbine is used for testing centrifugal and axial-flow compressors. It provides speeds up to 9,000 rpm.

The long, trouble-free life of Terry high-speed turbines stems from two sources: (1) more than 50 years of successful experience in making turbine drives *exclusively*, (2) a willingness to build *something extra* into each machine to assure its reliability.

There's a reliable Terry turbine for you in sizes up to 6000 hp. In special cases higher outputs can be supplied.

For more information about Terry multistage turbines, ask for a copy of bulletin S-146.

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THE TERRY STEAM TURBINE COMPANY
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HYDRAULIC SCRUBBING TOWERS

GIVE UP TO 99.9% COLLECTION EFFICIENCY*

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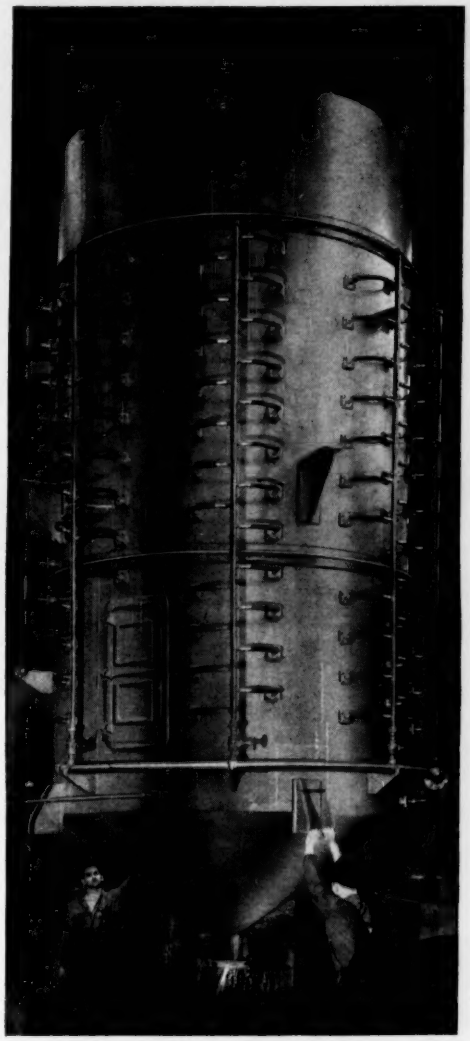
Where air cleaning equipment is required to withstand high temperatures, sticky, corrosive or abrasive dusts, fumes or gases in any combination, "Buffalo" Hydraulic Scrubbing Towers offer many important advantages. These compact, economical units provide high efficiency, plus the ability to stand up under the most severe conditions. A combination of centrifugal force, a finely atomized spray system and scrubbing against a wetted surface are utilized to give maximum effectiveness.



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*Phosphate Rock Drying Operations — Installation of "Buffalo" Scrubbing Tower resulted in a collection efficiency of 99.9% *plus*. Before the installation, clouds of effluent obscured vision in the surrounding community. After installation, no trace of contaminant was present in the outlet stack. Careful tests show the absolute cleaning is now down to .06 grains per cu. ft.

- Lime Calcining Operations
- Control of Coke Breeze
- Manufacture of Chemical Alloys
- Fungicide Manufacture
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- SO_2 or SO_3 problems

If you have an air cleaning problem in your plant, contact your "Buffalo" Engineering Representative today, or write us direct for literature. "Buffalo" manufactures a complete line of air purification equipment, including: Gas absorbers, wet glass cell air washers, rotary multi-stage gas scrubbers, scrubber washers, static washers, hydro volute scrubbers, cupola washers, multi-cyclone dust collectors and hydraulic scrubbing towers.

"Buffalo"

BUFFALO FORGE COMPANY

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Buffalo Pumps Division • Buffalo, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

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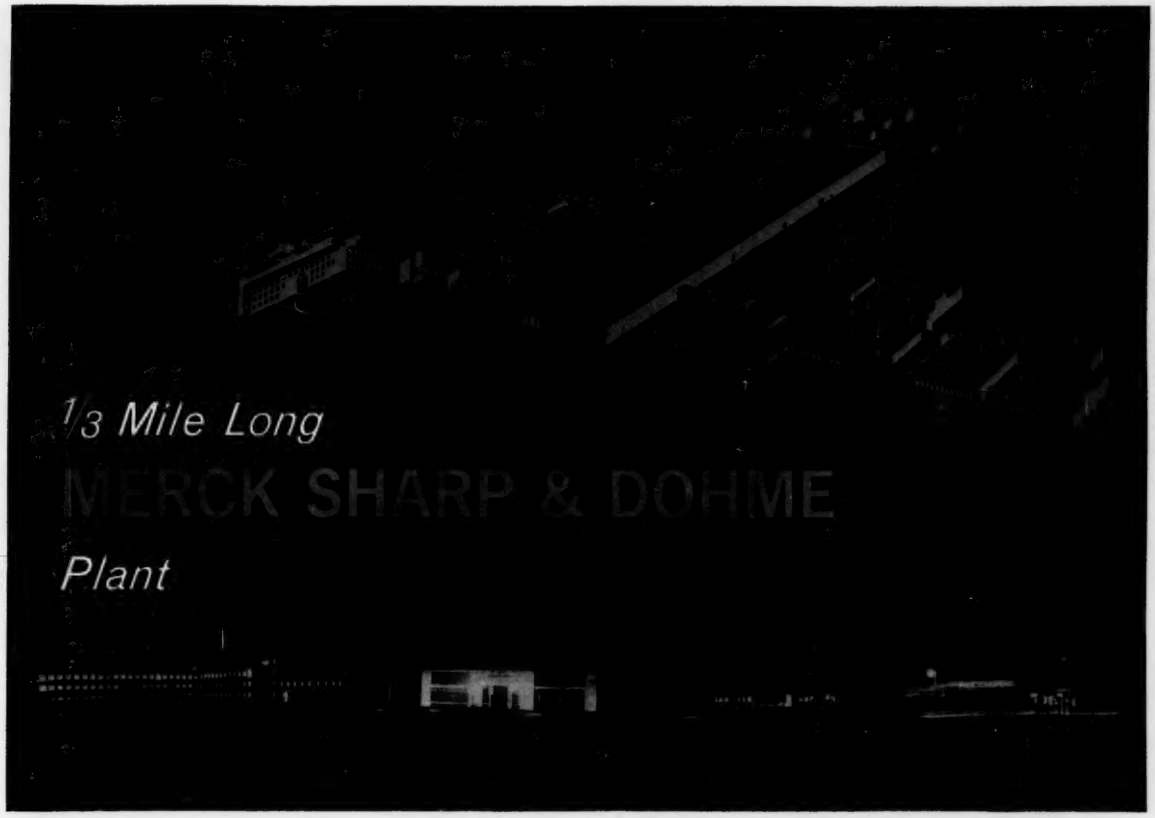

where dependability of pipelines is a must, control is entrusted to JENKINS VALVES

World famous Merck Sharp & Dohme, division of Merck & Co., Inc. not only knows pharmaceuticals and biologicals; they know a lot about valves. They need to! Control of pipelines must be *unfailing*.

That's why you'll find Jenkins Valves on all process pipelines in this West Point, Pa. plant . . . as well as on plumbing, heating and air conditioning lines.

The Jenkins name is not new to Merck Sharp & Dohme. They have been using Jenkins Valves extensively for the past twenty years. The unusually large number of valves installed in the company's seventeen domestic and foreign plants represents a big investment. So you can be sure this experienced valve buyer has found Jenkins Valves both dependable and maintenance free.

Jenkins dependability can save money for any plant or building. What's more, you can specify or install Jenkins Valves at no extra cost. Jenkins Bros., 100 Park Avenue, New York 17.

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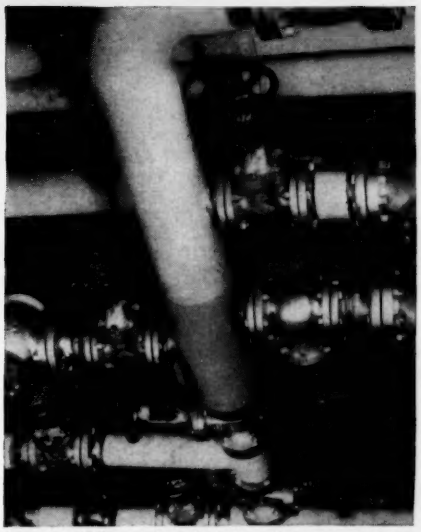

Jenkins Valves on main steam lines serving the Biological buildings

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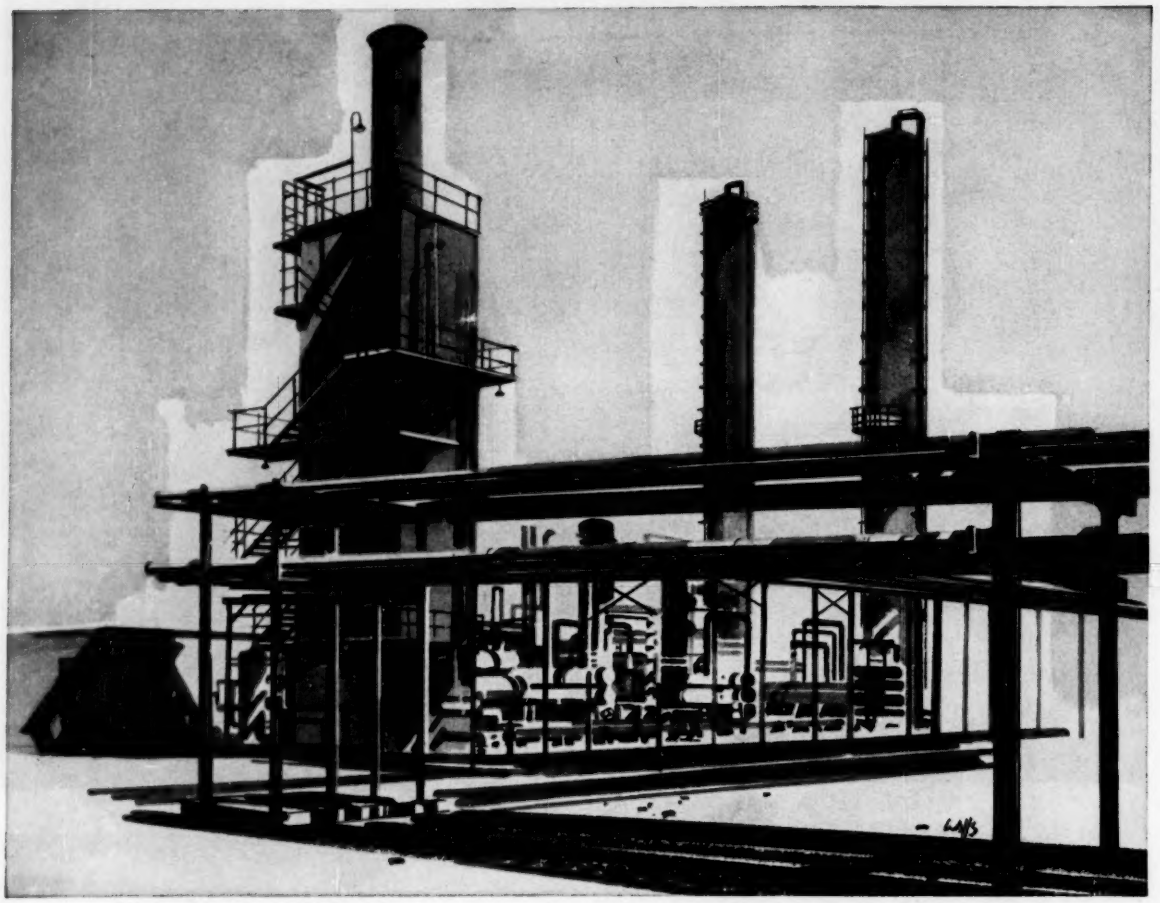
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS SINCE 1864 Jenkins Bros.



Building new horizons in the process industries...

ALL THE HYDROGEN YOU NEED—ECONOMICALLY!

Name the quantity of hydrogen you need and the purity required. Tell us what the feedstock will be. Then let J. F. Pritchard & Company determine how to get *all the hydrogen you need* at lowest possible cost.

Pritchard design and construction follow an integrated pattern, focused on one central theme: our experienced engineering team is devoted to balancing the factor of low initial cost against those of plant efficiency and operating cost. Desire for minimum production cost dictates processes and operating conditions which achieve maximum return per dollar invested. We, at J. F. Pritchard & Co., call this concept "Good Financial Design."

Whether you would like to derive hydrogen from refinery gases . . . to reform natural gas or propane . . . or to rely on electrolysis for carbon-free hydrogen, we can fit the plant and process to your available raw material. Let us show you how to get all the hydrogen you need, at lowest possible cost.

PROFITABLE FACILITIES THROUGH GOOD FINANCIAL DESIGN

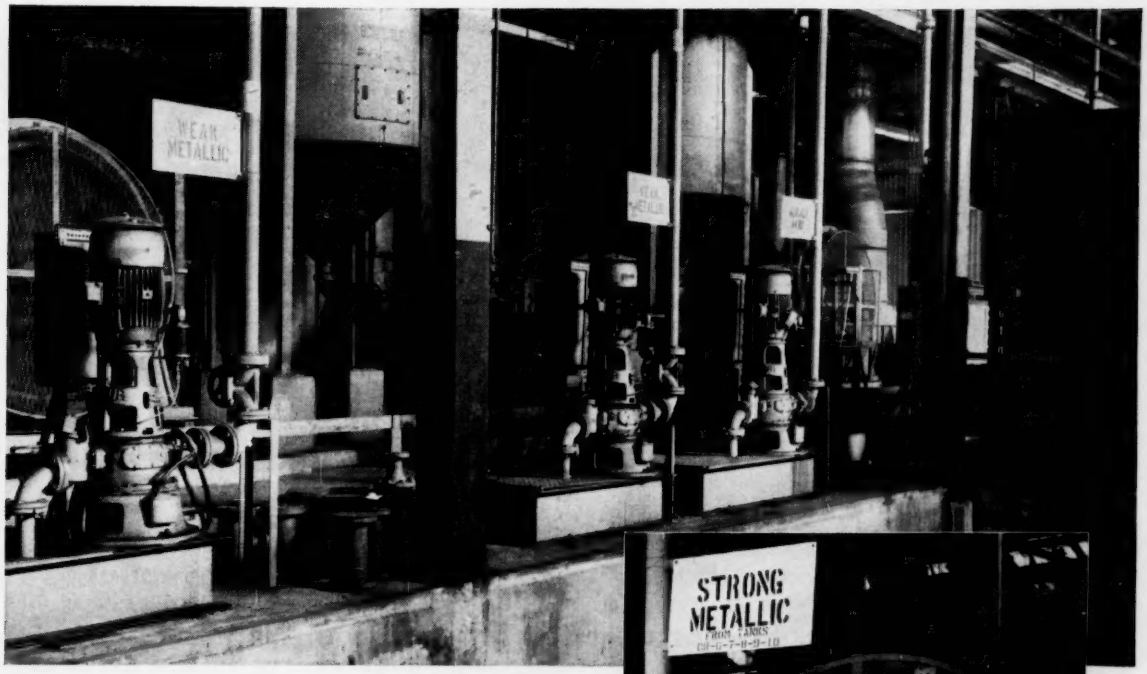
J.F. Pritchard & Co.

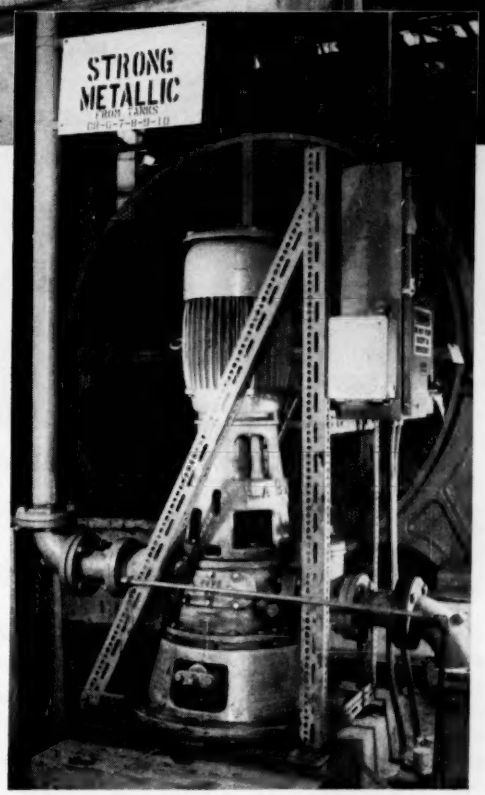
ENGINEERS • CONSTRUCTORS

4625 Roanoke Parkway, Kansas City 12, Mo.

OFFICES IN CHICAGO, HOUSTON, PITTSBURGH, NEW YORK

SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES





Daily Job:
Move a Million Gallons of Corrosive Liquids

Industrial waste treatment at this large automotive manufacturing plant calls for neutralizing 1,500 gallons of noxious solutions per minute. Some 150 LaBour pumps handle the cyanide, metallic acids, alkali and other corrosive liquids involved in cleaning and plating operations. Every day more than a million gallons of such liquids are pumped.

Highly satisfactory performance of the LaBour pumps is reported by the operating staff. The pumps are packingless, and maintenance is at a minimum.

Your problems with corrosive liquids may be different, but you can depend on LaBour to solve them. Competent application advice is yours for the asking. Write us today.

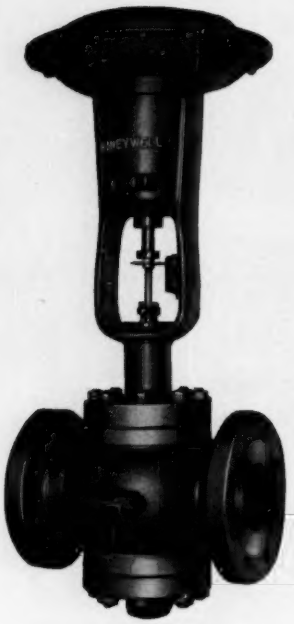
ORIGINAL MANUFACTURERS OF THE SELF PRIMING CENTRIFUGAL PUMP

LABOUR

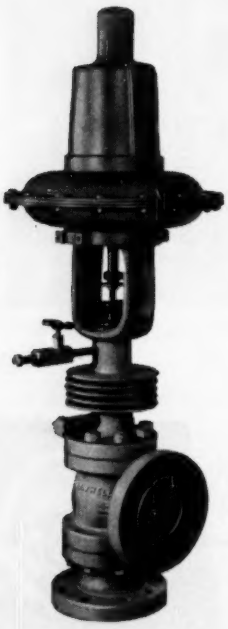
THE LaBOUR COMPANY, INC. • ELKHART, INDIANA, U. S. A.

is your

PROCESS FLOW EROSIVE?

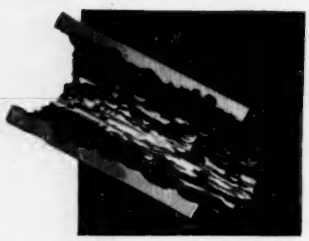


Type 11, double-seated



Type 10 angle valve

Honeywell control valves are available for a wide range of conditions



Whether you're talking about suspensions or high pressure drops, there's a Honeywell automatic control valve for your erosive process flow. The new Honeywell Type 10 angle valve is excellent for slurries, viscous or flashing flow mediums . . . all Honeywell valves are available with a variety of trim for high pressure drop service. Choice of trim, for any type of erosive condition is made from 17-4 PH, *Stellite*, 440C and *Colmonoy* Coating.

For erosive or non-erosive flows . . . or other process flow conditions . . . Honeywell valves are available in a wide range of types and sizes. When you need control valves . . . contact your local Honeywell field engineer. Write for new Catalog C800-1.

MINNEAPOLIS-HONEYWELL, Fort Washington, Pa.

Honeywell

H HONEYWELL *First in Control*

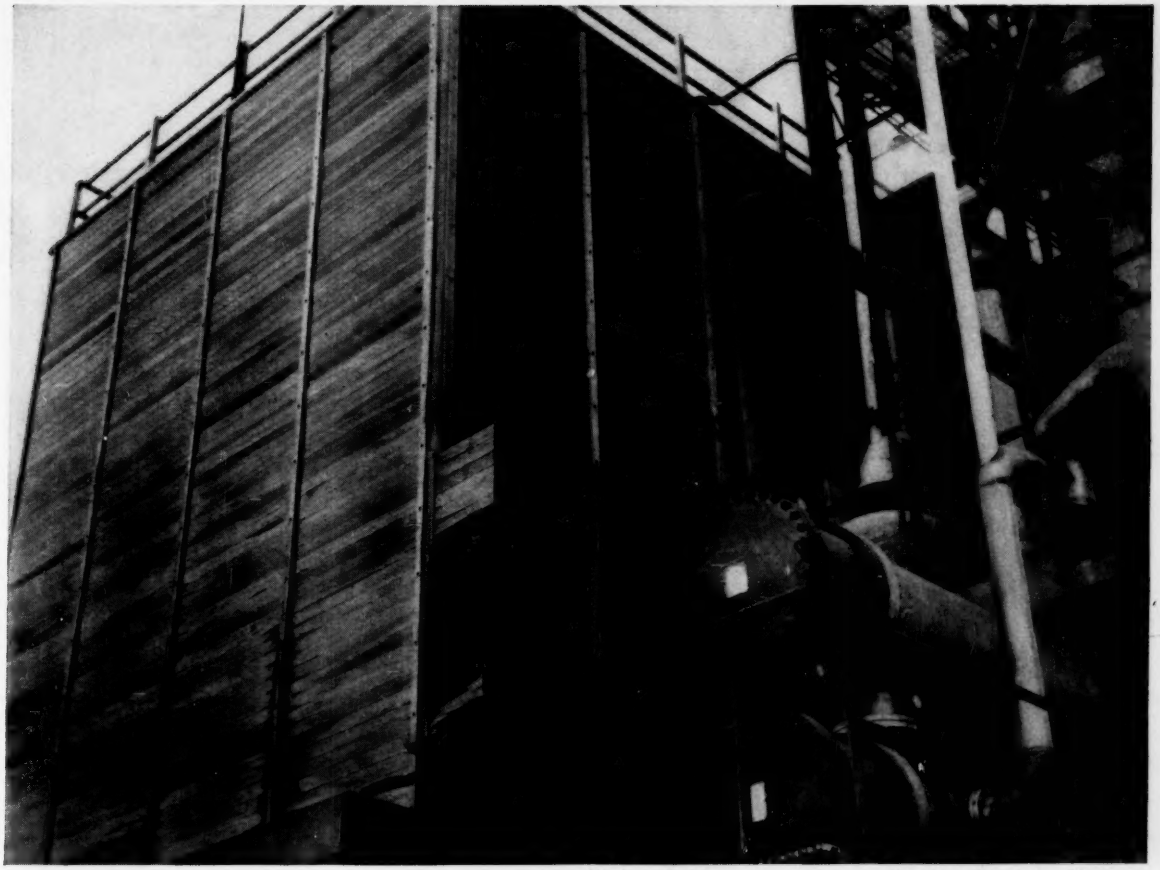


Photo and information, courtesy of Chemical Processing Magazine

Going two years! Nickel Stainless Steel doubles life of nitrogen oxide exchangers

...has already saved thousands with more savings to come

Until recently, corrosion of heat exchangers at the Cooperative Farm Chemicals Association plant in Lawrence, Kansas was an acute problem. Sometimes the exchangers, used to cool nitrogen oxides, had to be completely replaced within a year . . . at a cost of thousands of dollars.

Now comes word that nickel-containing Type 304 stainless steel exchangers . . . the ones shown above . . . have lasted two years. And they are expected to be on-the-job for some time to come. The units were made by Western Supply Company of Tulsa, Oklahoma.

Temperature is reduced 410° F

As a step in the production of 57% nitric acid, the units take nitrogen oxides derived from ammonia oxidation and cool them from 500° F to 90° F. Each exchanger has 1305 square feet of cooling surface. Surface is obtained with 473, ¾-inch tubes. Tubes are Type 304L stainless steel. With the exception of channel side and external bolting, shells are also Type 304.

Other savings

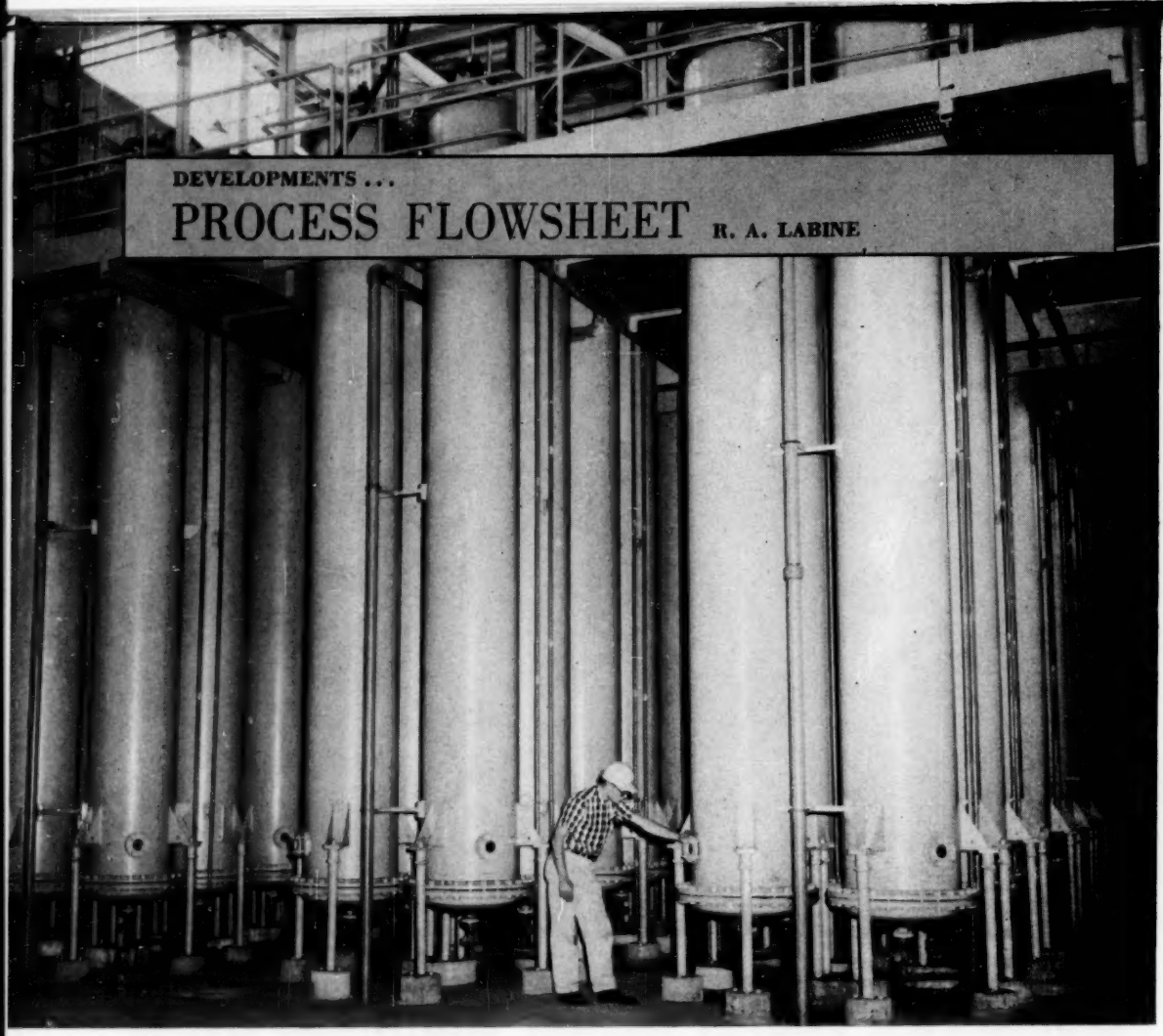
In addition to eliminating early replacement cost, the use of nickel-containing stainless steel in these exchangers is materially reducing general maintenance and down time.

In thousands of other chemical processing applications, nickel-containing stainless steels are doing as much or more. Contact your fabricators about these useful steels. Or go to the producers of stainless steel for information. Ask them to suggest places where a stainless steel specification can save money in your plant.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER



DEVELOPMENTS . . .

PROCESS FLOWSHEET

R. A. LABINE

Forest of ion exchange columns for . . .

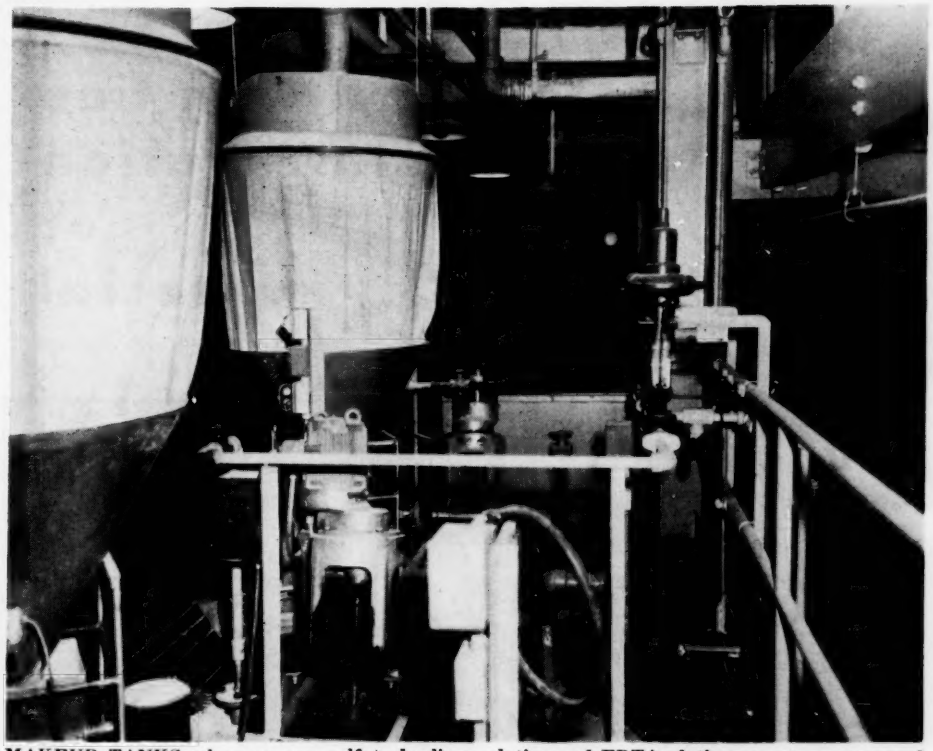
Mass Production of Pure Rare Earths

As anyone in the rare earths business will tell you, the rare earth elements are neither rare nor are they earths. Testifying to the fact that these elements are not rare is Michigan Chemical Corp.'s big rare earths facility at Saint Louis, Mich., which has been in operation since 1956. This plant can turn out "several" tons per month of 12 heavy rare earth oxides and metals.*

MCC's plant employs the ion exchange process originally developed by F. H. Spedding at Iowa State College to separate rare earth mixtures into products more than 99% pure. To make this separation in quantity requires a forest of ion exchange columns—plus some patience. It takes roughly five to six months

* praseodymium, neodymium, samarium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, lutetium, and yttrium.

Unfold Flowsheet



MAKEUP TANKS where copper sulfate loading solution and EDTA eluting agent are prepared.

Mixed rare earth c concentrate

from the time the mixed rare earth chlorides enter the system to the time the separated cuts drip out of the other end of the ion exchange train.

Markets for these pure rare earths are developing, albeit not as rapidly as some in the industry would like to see (see p. 80). Of the 12 pure elements currently turned out by MCC, yttrium metal and oxide are the biggest sellers. Yttrium has figured in the headlines recently because of the Bureau of Mines development of ductile yttrium and the Atomic Energy Commission's interest in yttrium's low thermal neutron cross section. Michigan Chemical is also one of the co-sponsors of the program at Battelle Memorial Institute to develop new applications for the pure rare earths.

▶**IX Principle**—Ion exchange process that goes on inside the train of columns involves "stability constants," a factor related to the elements' ability to displace ammonia or hydrogen ions in the solvent (eluting agents) used to elute the resin beds. Heavy rare earths have stability constants increasing with increasing atomic number. The higher the stability constant, the more readily a rare earth will displace ions in competition with a less stable rare earth.

Here's how this principle is exploited to separate a mixture of rare earth chlorides: First, the chloride mixture is loaded on a sulfonated polystyrene cation exchange resin. Then the solvent, ethylene-diamine-tetraacetic acid (EDTA), elutes the bed, rare earths on the resin changing places with ammonia or hydrogen groups in the solvent molecule.

Through billions of exchanges between the solvent and the bed, the most stable rare earth is picked up in the first slug of solvent, with succeeding portions of solvent carrying elements arranged in bands according to descending stability constants.

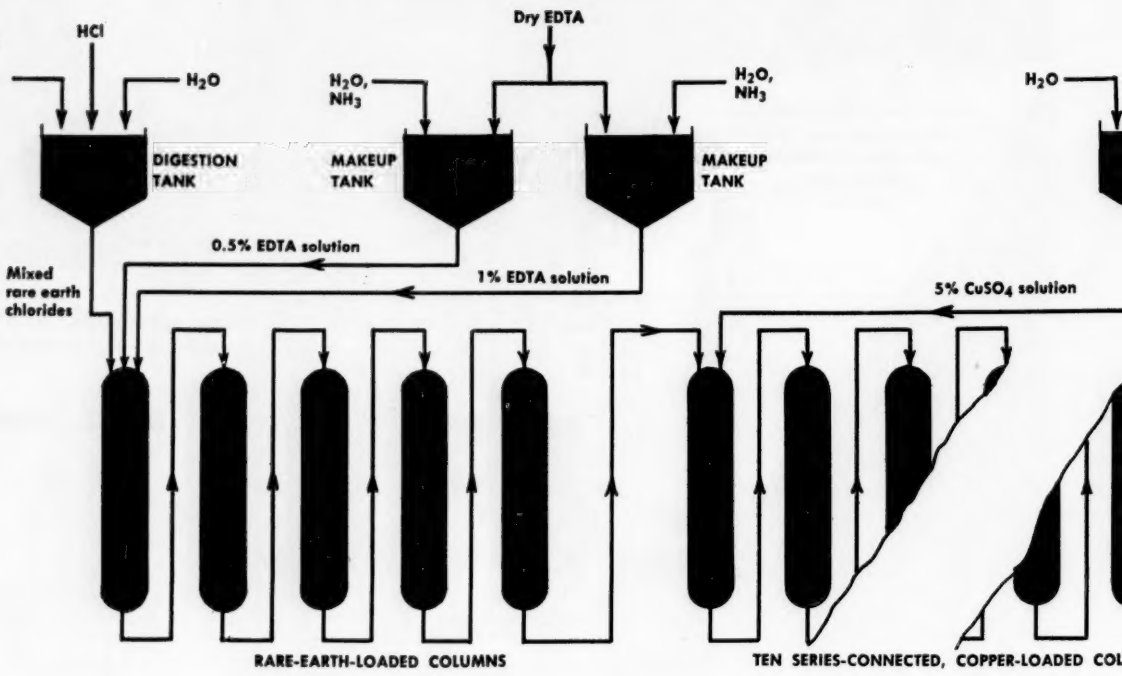
▶**Reduced to Practice**—In actual practice, EDTA solvent coming from the loaded resin bed does not have a sharp enough separation of the rare earths.

To get more separation, the EDTA solvent then flows to resin beds loaded with copper ions from a copper sulfate solution. Copper EDTA complex is more
the rare earths
replace rare ea
starting the sel
over again. Aft
copper-loaded co
first bearing cop
arranged in sha
constants.

Then it is jus
analytical watch
emerging stream
ate vessels when
solvent.

▶**Feed Preparati**
rare earth ore
which it mines o
chlorides for ion
in an HCl soluti
keted tank.

The EDTA sol
tions: 0.5% aque
of columns loa
stronger 1.0% s



is more stable than the most stable of earths (lutetium) and the copper will rare earths in the solvent molecule, the selective deposition-elution cycle ain. After flowing through a train of oaded columns, solvent finally emerges, ring copper ions, then with rare earths d in sharp bands according to stability s.

it is just a matter of keeping a close al watch on the composition of the g stream and shunting it into appropri- els when a new element appears in the

Preparation—MCC starts with a mixed rth ore concentrate (usually oxides) mines or buys. Oxides are converted to s for ion exchange feed by dissolving Cl solution in a glass-lined, steam-jac- nk.

DTA solvent is made in two concentra- 5% aqueous solution for initial elution mns loaded with rare earths and a 1.0% solution for final elution (strip- ping). Stronger solution is needed to separate rare earths against the more stable copper ion. The 0.5% solution is pumped at a 1.6 gpm. rate while the stronger solution flows at 0.8 gpm. to allow longer contact time.

▶ **Column Arrangement**—Ion exchange section of MCC's plant contains 175 columns measuring 30 in. dia. by 20 ft. tall. Only fifteen series-hooked columns are needed to carry out the separation process described above; with its large number of units, firm has capacity to carry out many different operations concurrently.

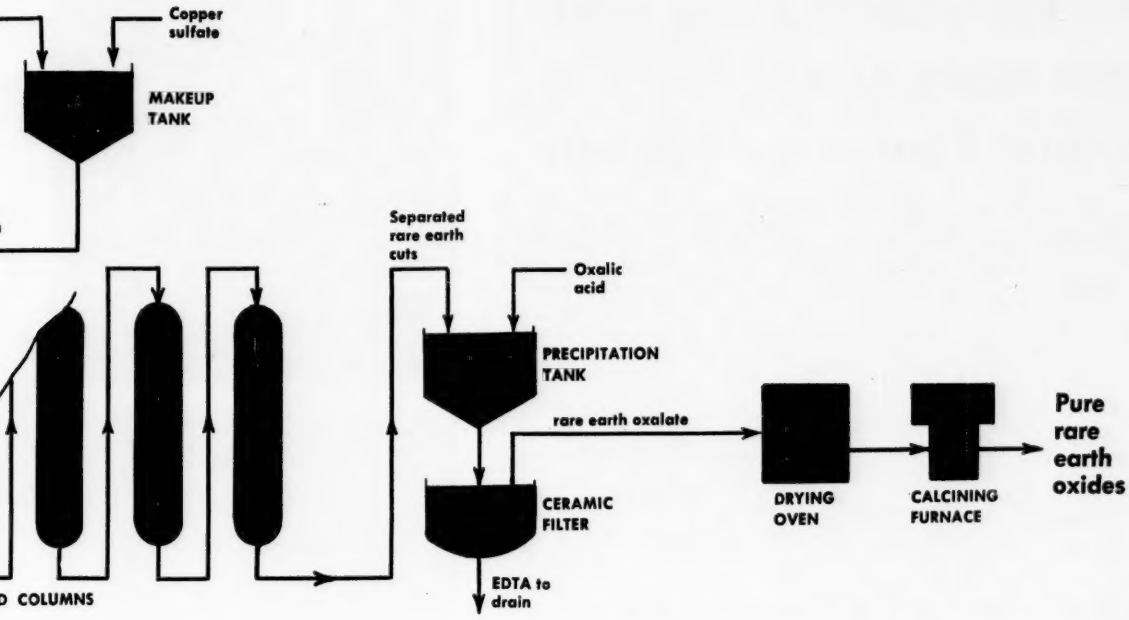
First five of the fifteen columns are loaded with rare earth chlorides; remaining 10 columns are loaded with copper ions. Solvent is pumped into the first column and allowed to run through the first six. First portion of the EDTA stream emerging from the sixth column contains copper ions which is discarded. As soon as the analytical checks show rare earths are coming through, stream is introduced into top of the seventh column. In the remaining columns, the whole sequence is repeated: copper is eluted and rare earths layed down on the resin, then picked up cording to stabilities.

As soon as the first they are reloaded w whole process started

▶ **Final Treating**—As the bottom of the 15 into a 500-gal., glass There oxalic acid pr oxalates.

Precipitate slurry p filter and oxalate ca quartz trays for drying is then calcined to ox furnace at 800 F.

If metal is desired, monium bifluoride an tube furnace at 350- fluoride forms. Fluori lum crucible and charg tion furnace where it in an inert argon a metals are then mark ingots.



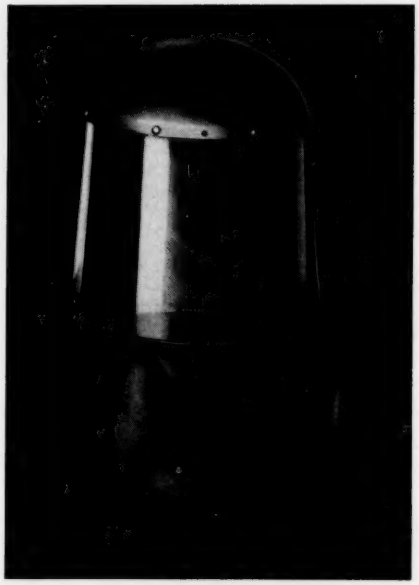
l up again by the solvent ac-
ties.
first five columns are stripped,
d with rare earths and the
rted over again.
-As each rare earth cut leaves
e 15th column, it discharges
glass-lined precipitation tank.
l precipitates rare earths as

rry passes through a ceramic
e cake is loaded into fused
rying 4-6 hr. at 300 F. Oxalate
o oxide by firing in another

red, oxide is mixed with am-
e and is placed in a gas-fired
350-650 F. where rare earth
uoride is then put in a tanta-
harged to a Stokes-type induc-
re it is reduced with calcium
on atmosphere. Rare earth
narketed in 1- to 3½-in.-dia.

PRECIPITATING TANKS receive rare earth cuts as they emerge from ion exchange train. Oxalic acid then precipitates oxalates of individual elements.

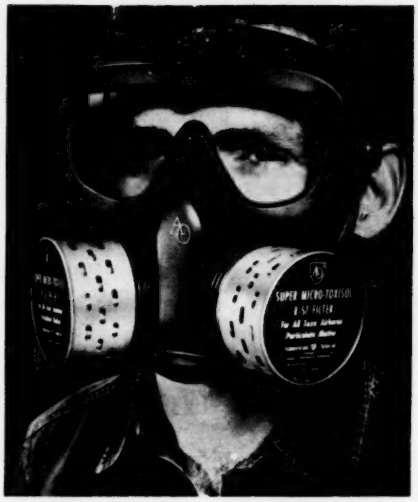
AO 157 CHEMICAL SHIELD



Yes, Full Head, Face and Neck Protection Against Chemical Splash

Here's eye, face, head and neck protection in one practical serviceable unit! Consists of vulcanized fiber headgear, rear drape and front bib of fire resistant neoprene coated fiber glass, and clear acetate window. Quick fastening studs and end clips hold window secure. Snap fasteners hold neoprene drape which encloses back of head and neck and hangs to shoulders. Bib attaches to lower edge of window and extends well down chest — splash can't enter under window when head is thrown back.

AO R4157 RESPIRATOR
ONE OF THE NEW R4000 SERIES

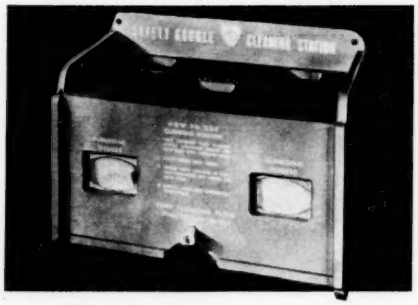


Cut Inventory Costs Way Down...26 Respirators in 1!

Cut costs, simplify inventory with the AO R4000 Drednaut Series — offering the greatest number of respirator and goggle combinations yet against a multitude of hazards! Facepiece and filters provide cost-saving interchangeability and AO high quality.

Recommended Uses: For exposure to dusts, mists, vapors, fumes and gases singly or in combination in the chemical industry, general industry, agriculture. Also for protection against radioactive particulate.

AO 750 LENS CLEANING STATION



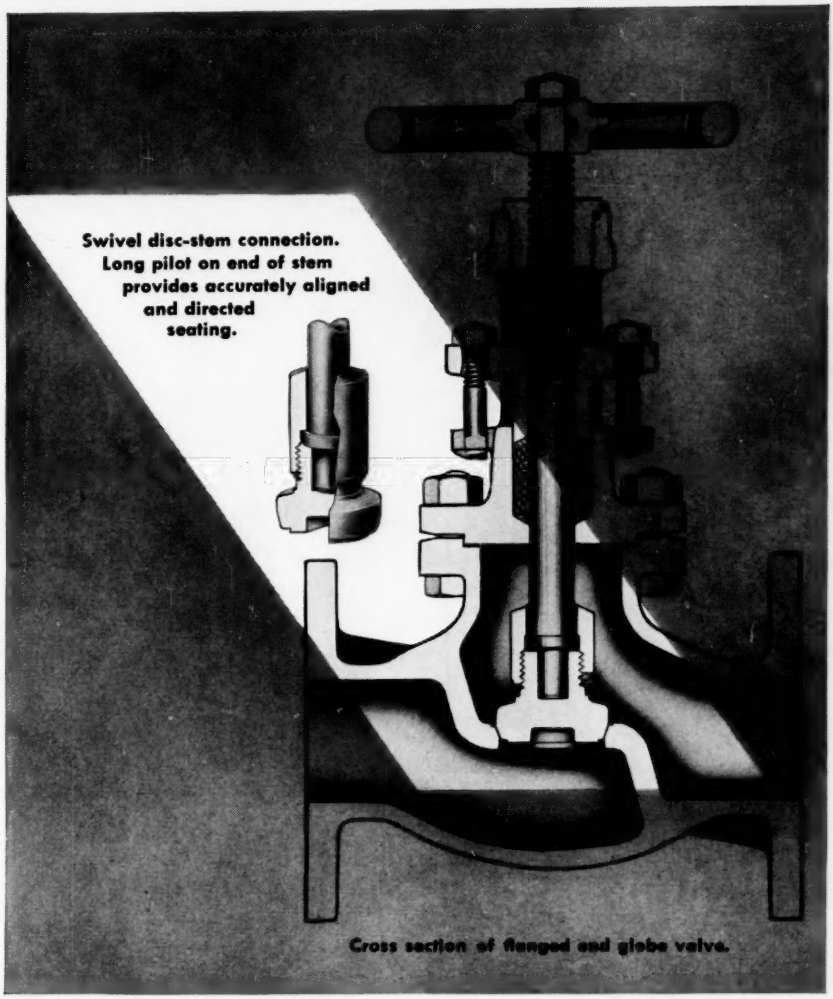
Excellent handy means for keeping goggles clean — ideal particularly for the chemical industry because cabinet is wood and will not corrode. Small, compact, it provides for all necessary cleansing and anti-fog materials. 12″ x 9″ x 6″, accommodates either our 750 F Lens Cleaning Fluid or our 350 AF Super-Clear Cleaning and Anti-Fog Fluid. Unit provides single sheet dispensing of cleansing tissue and disposal area. Attach station to wall at strategic plant locations and help your eye protection program pay off!

YOUR NEAREST AO SAFETY PRODUCTS REPRESENTATIVE CAN SUPPLY YOU

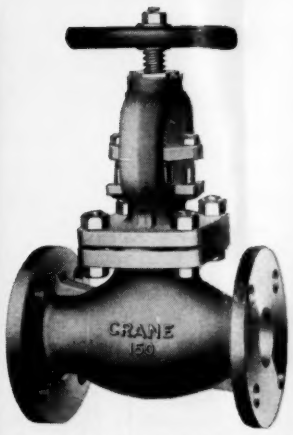
NOTE: Check your supply of AO Sweatbands. They keep workers cooler, comfortable, more efficient!

American Optical
COMPANY
SAFETY PRODUCTS DIVISION
SOUTHBRIDGE, MASSACHUSETTS
Safety Service Centers in Principal Cities

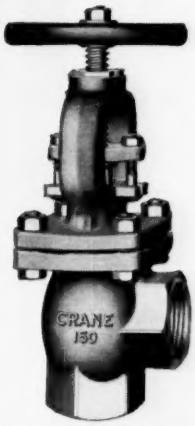
Always insist on Trademarked Safety Products



Cross section of flanged and globe valve.



No. 20011 globe. ½"-6", flanged ends; ½"-2", screwed ends.



No. 20012 angle. ½"-2", screwed ends; ½"-6", flanged ends.

Improved seating in "Craneloy 20" globes increases valve life

Here's a corrosion-resistant globe valve that's designed for throttling and other hard services in the control of process fluids.

Look at these important features:

A modified plug-type disc combines the easy seating of a narrow, ball-to-flat seat with the superior resistance to erosion, cutting and scoring provided by a wide, plug-type disc.

Crane's exclusive "guided disc" design brings the stem thrust closer to the seating surface and assures positive closure. Minimum clearance between disc and stem eliminates vibration and chatter, yet permits free swivel action of the disc.

All parts of the valve in contact with flow are "Craneloy 20," a high nickel, high chromium alloy cast under closest supervision in Crane's own foundry.

For complete specifications and recommended applications, consult your local Crane Representative or write to address below.

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Illinois—Branches and Wholesalers Serving All Areas

RAYMOND

Flash Drying

with fine disintegration of material

IN making certain types of powdered products which involve a drying operation, but no pulverizing, the Raymond Cage Mill Flash Drying System gives definite advantages in handling the job.

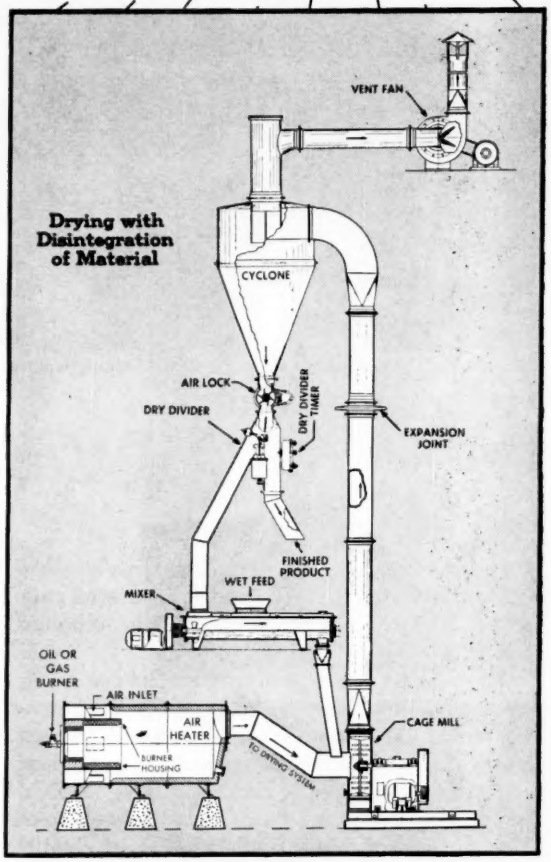
The Cage Mill disintegrates the material to normal particle size and simultaneously reduces the moisture to a specified final content, delivering a fluffy, free-flowing finished material.

Drying is instantaneous, and the small amount of fine material in the system at a time insures close control of the final moisture. This is important in handling heat-sensitive products.

High thermal efficiency plus clean, safe, dust-free, automatic operation are factors that simplify the process and add to the economy of the whole operation.

The system is flexible in application and where pulverizing is necessary, the Raymond Imp Mill may be used in place of the Cage Mill.

Write for further details and tell us your requirements.



This flow sheet shows a typical set-up for the Raymond Flash Drying System. The Mixer unit is used for adding a portion of the dried material to the wet feed . . . to disperse the moisture and permit efficient drying of the product. For processing treated clays, corn gluten meal, filter cake and similar materials.

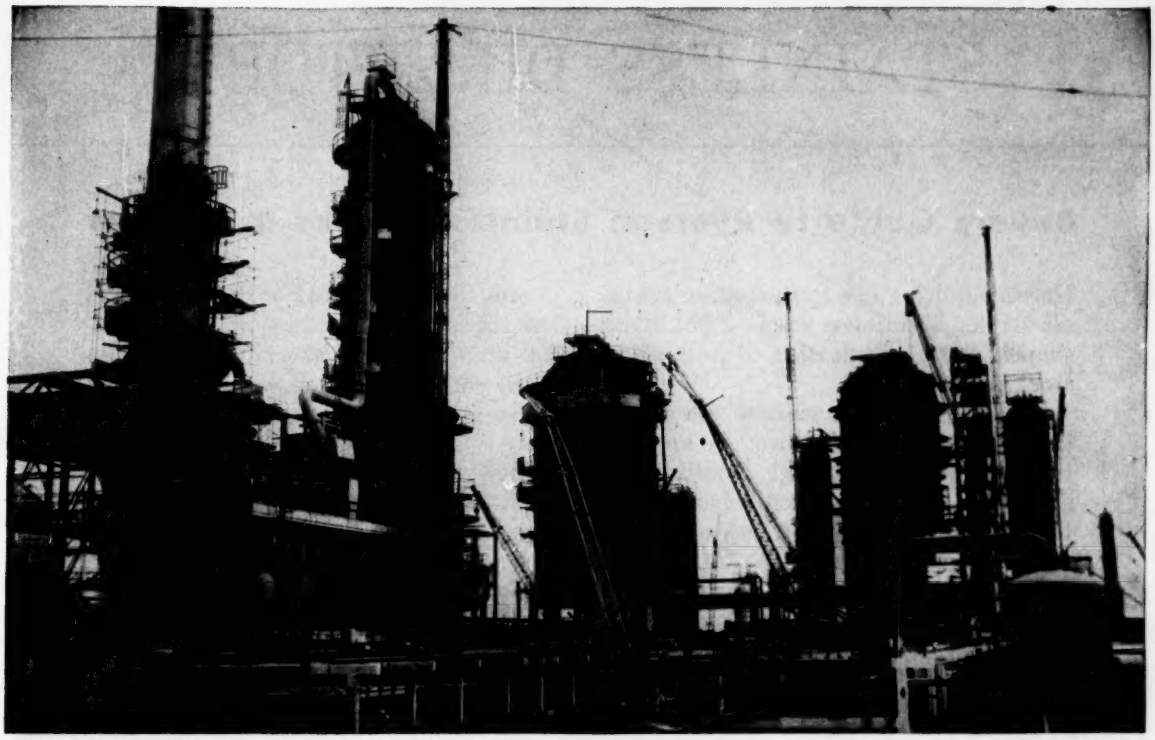
COMBUSTION ENGINEERING, INC.

Raymond Division

1112 W. BLACKHAWK ST.
CHICAGO 22, ILLINOIS

SALES OFFICES IN PRINCIPAL CITIES

Combustion Engineering-Superheater Ltd., Montreal, Canada



A dozen vessels built by Newport News were furnished under contract with C. F. Braun, Inc., of Alhambra, Calif., design engineers for the ultra-modern Delaware Flying A Refinery of the Tidewater Oil Company located 15 miles south of Wilmington.

Newport News builds 12 major components for new Flying A 130,000-bpd refinery

This is the Tidewater Delaware Flying A Refinery while under construction near Wilmington.

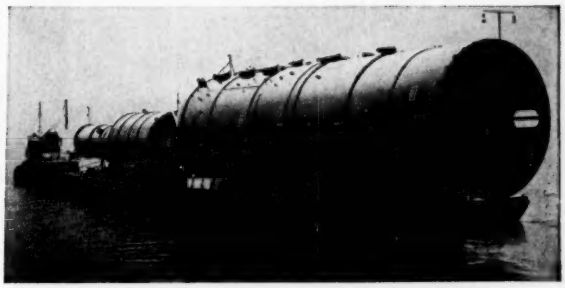
Newport News fabricated 12 of its major vessels — 2 of which are the largest such units ever built: a 250′ Orthoflow fluid "cat cracker" converter and a 225′ reactor scrubber of the fluid coker.

More notable than size, though, is the quality of the Newport News fabrication.

Coke-out screens in the reactor scrubber, for example, are made of 704 12% chromium segments. Welded together with accuracy, they provide 45% clear opening . . . with opening tolerances less than 1%.

You get expert fabrication, the skill of specialists when Newport News builds your equipment. When you want reactors, pressure vessels, vacuum tanks and the like, sub assemblies or weldments in almost any size or shape, get a bid from Newport News.

Send for newly published, easy-to-read, illustrated booklet, "Facilities and Products". It describes the many ways in which Newport News can help you with present or future projects. Write for your copy today.



Full advantage was taken of the Newport News deep water loading facilities for transportation of all of the equipment by barge. Shop erection prior to shipment assured fast, trouble-free field assembly.

Engineers: Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia

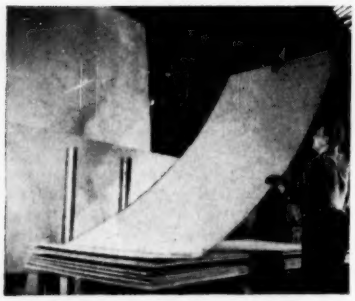
STAINLESS DIRECTORY

Buyers Guide to Ryerson Stainless Stocks & Services

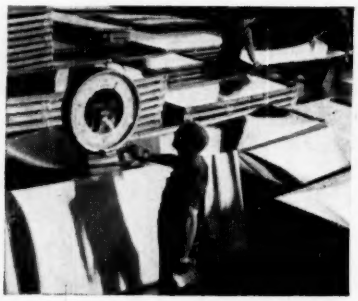
Here's a quick guide to the nation's largest stocks of stainless steel—2,351 sizes, shapes, types and finishes of stainless in stock at Ryerson.

This wide selection assures you of getting the best stainless for every application. Extra care in storage, handling and shipping—such as padded shear clamps to protect finish and flatness of sheets, guards the high quality of Ryerson stainless stocks. And in addition, the help of full-time stainless specialists is yours when you call Ryerson.

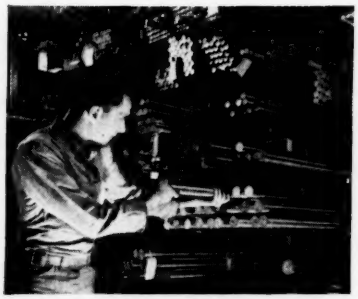
See your Ryerson catalog for a complete listing of stocks and call your nearby Ryerson plant for quick shipment of stainless—any type or size—one piece or a truckload.



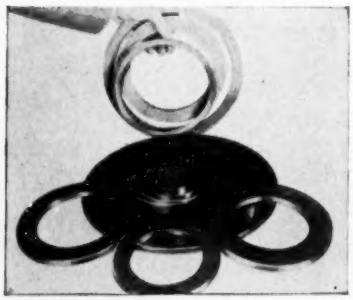
PLATES—Available in 9 analyses including plates to Atomic Energy Commission requirements and to ASTM specifications for code work. Also low carbon types for easy welding.



SHEETS—11 analyses of Allegheny stainless sheets in stock including nickel and straight chrome types. Also extra wide sheets to reduce welding costs, expanded and perforated sheets.



BARS AND ANGLES—Rounds, squares, flat's, hex's and angles in 8 types including free-machining bars with both analysis and mechanical properties controlled.



RINGS AND DISCS—Machine cut to your order. This service assures size accuracy, smooth edges, flatness and unaffected corrosion resistance in a lower-cost, ready-to-use product.

HEADS—A.S.M.E. flanged and dished heads in types 304, 304L, 316 and 316L are on hand in large quantities, and in a wide range of gauges and sizes.

PIPE AND TUBING—Light wall, standard and extra heavy pipe, ornamental and regular stainless tubing. Also screwed type and welding fittings and Cooper stainless valves.

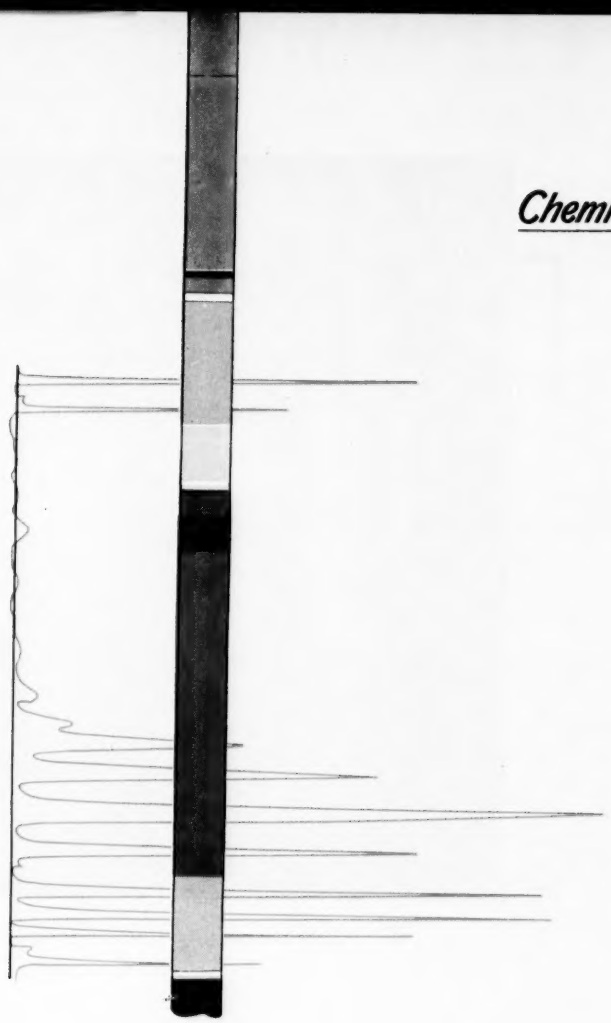
I·V·B·M
Increased Value in Buying Metals
Ask about this Ryerson Plan for 1959

RYERSON CERTIFIED QUALITY

RYERSON STEEL
Member of the INLAND Steel Family

STEEL . . . ALUMINUM . . . PLASTICS . . . METALWORKING MACHINERY NATION'S MOST COMPLETE SERVICE CENTERS IN PRINCIPAL CITIES COAST TO COAST

Chemical Engineering
JULY 27, 1959



In-Process Gas Chromatography

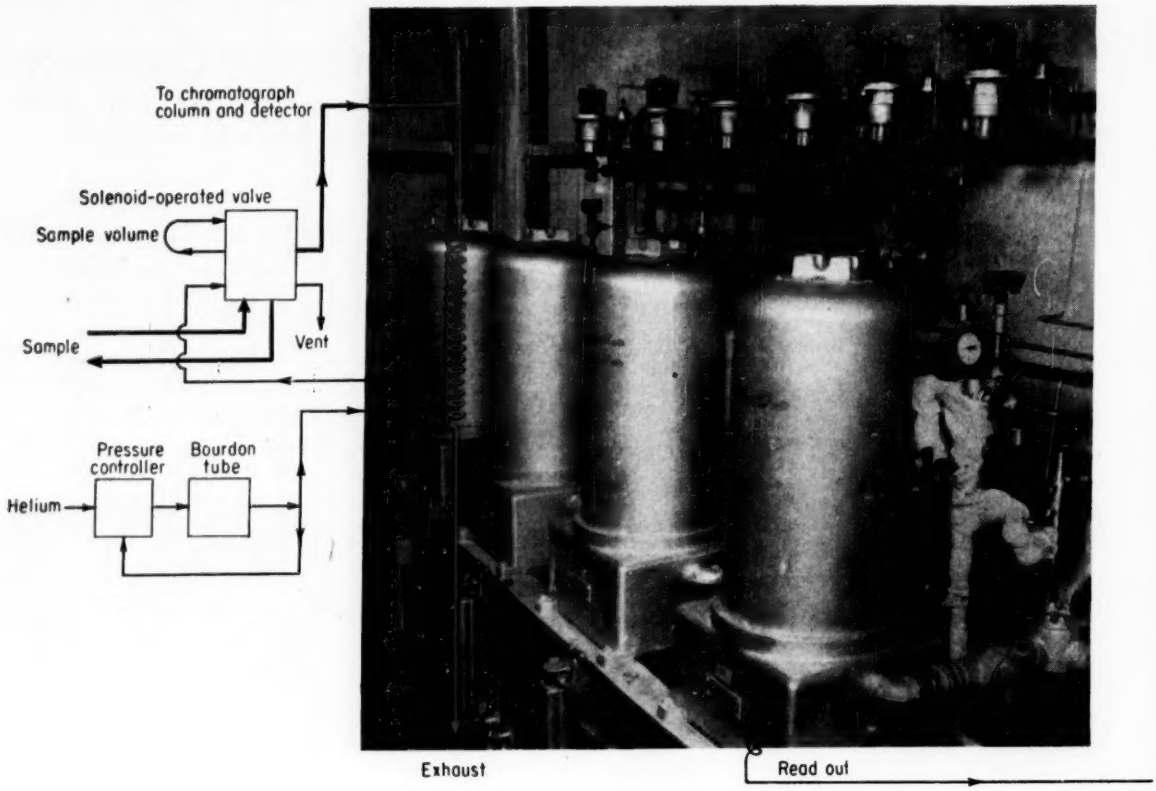
- This "greatest advance since spectroscopic methods" has moved out of the laboratory into the plant.
- **It's now a major factor in process-stream analysis.**
- Here's how it works; advantages, disadvantages.

E. E. ESCHER, Consolidated Electrodynamics Corp., Pasadena, Calif.

GAS chromatography has conquered many fields since its introduction a few years ago. One of the most significant developments has been its use for monitoring process-plant streams.

Much is happening in the fast-moving area of in-line chromatography. This includes modular designs, new techniques for difficult materials, direct process control applications. Also, useful operating costs are now available based on actual plant experience.

The big appeals of chromatography are low cost, simplicity, precision and wide applicability. Gas chromatography is a special variation of a more general technique of separating the components of a mixture by flushing them past a sta-



tionary phase for which they have varying absorption affinities. The stationary phase may be a low-vapor-pressure liquid (silicone, for example) deposited on granules of an inert, porous material (diatomaceous earth or firebrick). This packing is put into a column, usually a simple piece of ¼-in.-diameter tubing.

The sample may be any kind of gas, liquid or solid which can be vaporized. A portion of it is injected at the head of the column and flushed through by a carrier gas, normally helium.

Heavier components of the sample are more soluble in the liquid on the column packing and remain in solution longer than the lighter ones as they are swept from granule to granule. Advantage may also be taken of other properties, such as chemical or physical attraction or adsorption, to spread apart close-boiling materials. In this way, the components are separated and issue from the column in bands, mixed with the carrier gas.

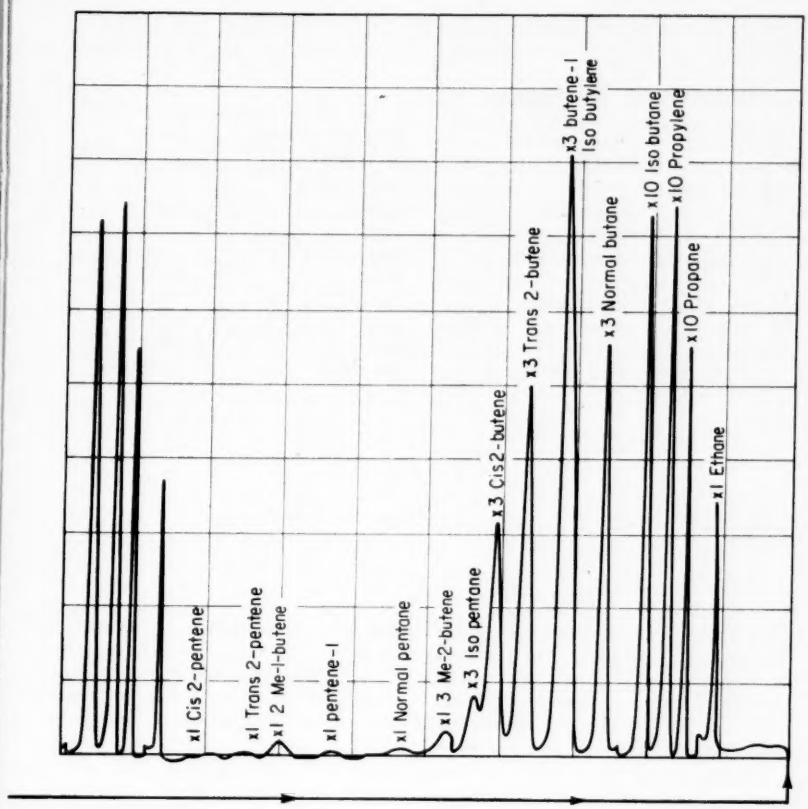
Several other parts are required to make the complete chromatograph. The block diagram shows the more essential parts of—in this case—a process chromatograph. You need flow control for the carrier gas; a constant-volume valve to introduce the sample; heat and thermostating for the column and introduction system; a detector (usually a thermal conductivity cell) to indicate and measure the peaks as they emerge from the column; a power supply for the detectors; a recorder; attenuators to bring the peaks on-scale and adjust sensitivity; and a timer to program the sample introduction, recording, attenuation and other operations. This analysis is a batch process—a second sample cannot be sent through the system until all components of the first emerge completely from the column.

In practice, carrier gas first goes through the detector unit to balance the cell. As soon as a component appears in the gas, the cell is unbalanced and a peak appears on the chart.

Usual process chromatograph consists of three modules. The explosion-proof analyzer unit in the dome is installed at or near the sample point in the plant or refinery. All the operating controls and adjustments are in the control unit, which is normally located in the control room alongside or under the recorder. These may be 500 ft. or more from the analyzer.

Modules Are Popular

A lab chromatograph looks a lot different from a process instrument, but it's basically the same. Sample introduction and attenuation are manual rather than automatic. Otherwise, the main difference is in the application. A lab chromatograph may be used for



How In-Line Chromatograph Works

Helium carrier-gas flows through the reference side of a detector (thermal conductivity cell), then into a control valve where it picks up the sample and sweeps it into the chromatograph column. Components separate by selective absorption, exit with the helium at different times, and go into the detector.

Results are recorded as a series of peaks on a strip chart. Amount of each component is a function of peak height or area under each peak.

control testing, where it will do the same analysis day in and day out, but more likely it will be used for a wide variety of things. It needs to be flexible for different modes of operation and quick changeover.

The process chromatograph repeats the same analysis month after month. And it is in the hands of plant operators who may be unskilled in instrumentation. A high on-stream factor, stability and repeatability of calibration are most important. Everything about it, from operation and maintenance to presentation of data, must be as simple and foolproof as possible.

Because a process chromatograph is used for just one purpose, the buyer usually wants it tailored to that job. For this reason, about half the instruments sold are specials. Manufacturers are meeting this problem by using building-block modules which can be slipped in to take care of varying numbers of components, attenuation and streams, and other special modifications.

Sample handling and conditioning is a big problem with process chromatographs, as it is with other monitoring instruments. Most users would like to buy a complete sample system from a qualified and experienced supplier. Since each sample system is different, and each is tailored to the particular application, this usually isn't possible. But instrument manufacturers have gone a long way toward solving this problem by providing or stocking most of the more specialized components, and supplying some complete assemblies such as multi-stream sample manifolds.

How Much Can It Save?

In spite of its simplicity, the chromatograph is probably appliable to as wide a range of problems as any analytical instrument. In petroleum these include everything from pilot plants through crude units, cracking, alkylation, reforming, natural gas and gasoline, plus most chemical and petrochemical operations.

Should you have chromatography for your plant? The main criterion, of course, is how much it can make or save you. A few laboratory chromatographs may be bought on other than strictly economic justifications, but payout time usually is the deciding factor for a process instrument.

A process chromatograph costs about $5,000 with its recorder, more if the price includes a fancy sampling system or special modifications. The shorter the payout, the better the justification for installing an instrument, but most companies seem to feel that it should be about a year or less.

Low Operating Costs

On first reports, the process chromatograph seems to have scored well on both payout and operating costs. Denny[8] attributes propane recovery gains of $10,500/mo. to chromatographic monitoring of de-ethanizer absorber product at Sunray's Snyder, Tex., gasoline plant. In addition, several other less tangible benefits were noticed. Plant operation is now smoother and better understood. Upsets are less frequent, especially when changing

How Chromatograph Compares With Other Analyzers

	Chromatograph	Mass Spectrometer	Infrared
Approximate price	$5,000	$6–17,000*	$4–10,000
Simplicity	simplest	most complex	complex
Maintenance cost	lowest	highest	higher
Calibration stability	best	good	good
Interference problems	generally least	intermediate	most
Ease of calibration	fair	good	good
Versatility	intermediate	best	least
Threshold sensitivity	ppm.	ppm.	ppm. to %
Flexibility	good	best	poor
Frequency of analyses	2-30 min.	continuous	continuous

* Explosion-proof

feeds. Operating costs of the chromatograph: $500/yr. Sunray is now monitoring other plant streams and planning further installations.

McGovern and Carlisle[11] applied a process chromatograph to a deisobutanizer in an alkalation unit at Magnolia's Beaumont refinery. This column seemed to be operating under stable conditions when controlling by conventional methods, but the chromatograph analyses showed that compositions were varying enough so that savings of several thousand dollars a month could be realized. Again some incidental benefits were gained. It was found, for example, that the temperature and pressure controls on the column were inadequate and improved ones are being installed. Five other chromatographs are now being installed at various points in the refinery.

Spracklen and Halvorsen[10] computed a four-month payout for a complete analytical system on an ethylene production unit, using infrared analyzers and chromatographs.

Another somewhat unexpected justification for process chromatography has been a savings in control laboratory manpower. At first it was felt that a chromatograph would probably be able to monitor only a single stream with a given column and operating conditions, but this isn't true. Often a number of streams such as feed, overhead and bottom from a column or series of columns can be analyzed by one instrument. Several instruments are now being installed which monitor 12 or 15 streams on automatic cycle, the streams selected at the proper time by a solenoid-valve manifold actuated by the chromatograph. An analysis on a given stream may be obtained only every two or three hours, but this is still a lot better than laboratory analysis, and the savings in laboratory manpower are obviously great.

Why a Chromatograph?

Granted that the above examples show that a lot of money can often be saved by monitoring a plant stream with an analytical instrument, how do you decide whether to use a chromatograph or some other instrument?

The original enthusiasm for chromatography led to rash predictions that there were few, if any, problems it couldn't handle, and handle better than any other instrument. It was even predicted that other analytical instruments such as infrared, ultraviolet, and mass spectrometers would be virtually run out of business. As far as process monitoring is concerned, this seems to be proving very nearly true, but, oddly enough, over-all use of the other analytical instruments has increased at an even faster rate since the coming of the chromatograph. Part of this certainly is attributed to continuing increase in research and technical expenditures, and to the present trend toward process instrumentation. Some also seems to be a synergistic effect. The chromatograph has provided a general stimulus to the greater use of analysis, and has tended to make a lot of technical men take a closer look at the potential payout of analyzers. And, of course, the chromatograph, in spite of its versatility, hasn't proved to be the ultimate answer to every problem.

Each type of instrument will have certain jobs where it will shine. There will be others which will be difficult or impossible for it. And quite a few analyses can be handled fairly well by any of several instruments. For these, a comparison of some important characteristics should help in making a selection (*see table*).

The table shows three of the most popular stream analyzers. A lot of other types—ultraviolet, gravitometers, nephelometers, titrators, colorimeters, polarographs, refractometers—have their special fields of application.

New Developments Coming

Improvements in technology are making chromatographs basically simpler and cheaper. But at the same time, the users are demanding instruments that will do more and handle tougher problems. To meet these demands, new developments

have been coming thick and fast, and more are in the offing.

Multiple Columns "Precut"

Two difficult-to-handle samples are those which can't be separated on any one column, and those with a wide boiling range. With the latter type, either the light components aren't separated, or the analysis time become very long.

Several multiple-column techniques have been developed to handle these problems. A "precutting" modification traps out and purges the heavy ends of a sample to vent at the same time the analysis is run on the lighter ends. Backflushing records the heavy ends as a single lumped peak, but takes about twice as long as precutting. The dual-column uses two different types or lengths of columns in a series-parallel arrangement, where both heavy and light components need to be recorded individually. Several other such special arrangements have been developed for special purposes.

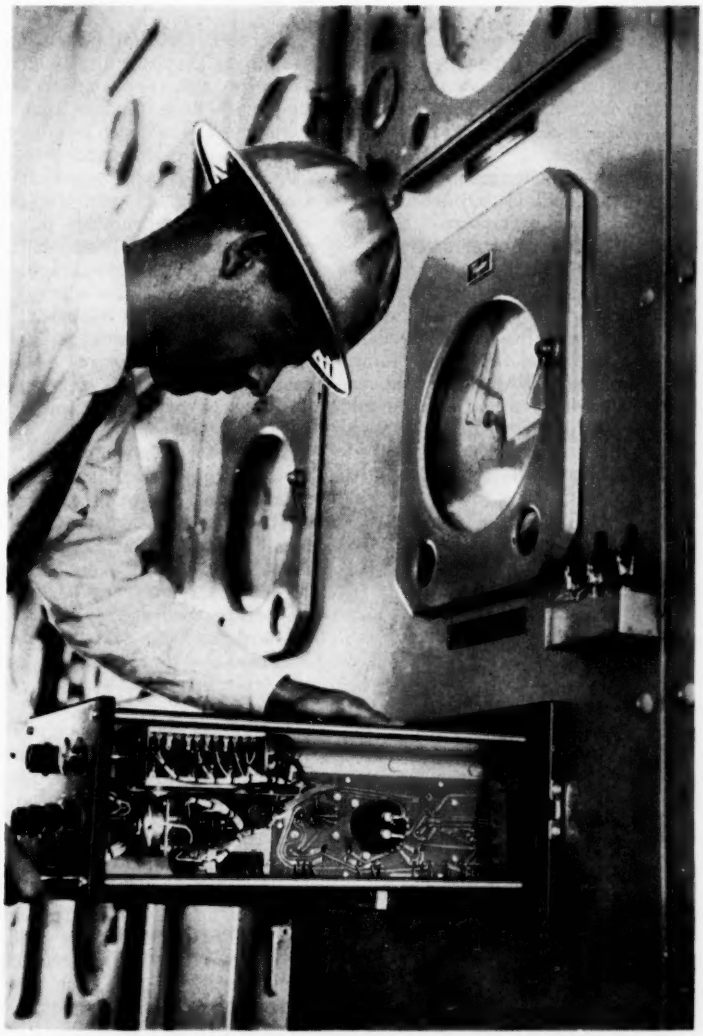
Another approach to running wide-boiling-range samples is programmed heating. The column is heated as the analysis progresses, to speed up the emergence of the heavy components. This technique has been applied successfully to laboratory chromatography. It hasn't yet been made available in a process instrument.

Direct Control Possible

Studies of the data gathered by monitoring and open-loop control have shown that the greatest economies from the use of chromatography will come from direct process control. Many users are now gathering information preparatory to going on direct control, and a few units have been on control now for some time.[7, 14, 15]

A number of methods have been proposed for converting the intermittent type of output obtained from the chromatograph for control. The simplest and most reliable seems to be the use of a peak-picker device in the recorder. At the time the peak to be used for control starts to emerge from the chromatograph, the programming timer in the chromatograph activates the peak-picker in the recorder. When the recorder reaches the top of the peak it remains at this level for a few seconds or minutes. During this period, a solenoid valve opens and the pneumatic control system is pressured to a level corresponding to the peak height. Then the solenoid valve is closed, locking in the pneumatic signal and the recorder is returned to normal operation. The signal is usually used in cascade, to reset the control point of a primary instrument such as a temperature controller.

Process control by stream composition will often provide an improvement in quality of automation over the use of environment-type instruments alone. The ultimate in both quality and degree of control will be achieved in the oft-discussed computer-controlled plant of the future. Several such plants are now nearing reality,[2, 4] at least on a small scale. Some question has been raised as to whether computers will be smart enough to eliminate the need for stream analysis, by correlating environmental factors more closely. But most experts agree that analyzers will still be needed, both to feed the computer directly and to supply



PROCESS CHROMATOGRAPH consists of three modules; operating controls and recorder in an instrument panel (above) and the analyzer.

information required to build and revise the mathematical model of the process which the computer will use.

For Faster Analysis

The analysis cycle on present-day conventional chromatographs is usually between 2 and 20 min. This has been fast enough to give good control on most of the processes on which control has been used. But faster analyses will be needed to give even closer control and to handle processes having faster dynamics than those so far tried. Two approaches to this are being used, both based on increasing column-resolving efficiency. The first uses conventional columns but optimizes all the factors of column design, sample size and operating conditions. This may give as much as a several-fold speedup in analysis time. The second method involves using capillary columns.[8, 12] These are simply long lengths—100 ft. or more—of capillary tubing, coated on the inside with a partitioning liquid. Because very small sample loadings are required, special detectors of the ionization type have to be used.[10] With these, analysis time can be improved as much as 5-10 fold. So far, capillary columns have been available only in laboratory chromatographs, but should also be useful for special process instruments.

The ionization detector, used with capillary columns, has other possibilities. Used with a conventional packed column, it can give threshhold sensitivities in the parts-per-hundred million range.

A logical ultimate in high-speed chromatography would be continuous chromatography, in which the sample is injected continuously and the concentration of the selected component or components read off continuously. Some work has been done on variations of the Hypersorption process[1, 2] using fluidized or moving beds of partitioner or adsorbent, but no practical, truly continuous chromatograph has yet shown up.

More Sophisticated Read Out

It is a truism that data taken are worth less than nothing if it is not used. For this reason analytical instruments have tended to develop along the line of more sophisticated read-out and data-handling devices. In chromatography, peak heights are linear enough with concentration for many practical purposes, especially over small concentration ranges, but peak areas are much more linear over the whole range. This has led to development of a number of peak area integrators. Different methods are used[5, 9] to read out the integral pipping pens, counters or printing counters now used.

Integrators haven't been used much with process chromatographs. Simple peak height is adequate for control purposes, especially over small concentration ranges, and is more precise. To avoid confusing the operator, only the peaks of interest are recorded, the rest being blanked out. To save chart paper and make a more compact record, the chart moves only when recording these peaks.

There are several other modes of peak presentation. If the recorder paper is moved only between peaks, a sort of bar-graph presentation is achieved. In a variation of this technique, a quadrant-type recorder is used. A new quadrant is advanced after each peak. Bar graphs of up to four different components are thus made in the four quadrants of the charts. Or a peak-picking device can be used to read and hold peak tops until they are recorded on a multipoint recorder, giving a separate trend line for each component.

There is another data handling problem that has been plaguing chromatographers for some time, especially in small labs. That problem is column information retrieval. Selecting a column and operating conditions for a given separation is still almost entirely an art, although a little science is beginning to enter in. There are literally hundreds of papers on the subject—too many for even an expert to be familiar with. The larger laboratories and instrument companies are solving the problem by putting the information on tabulating cards. And at least one abstracting group* is making such a service available on a subscription basis.

This isn't much of a problem with the process chromatograph because it's usually used for one analysis only. Besides, most instrument manufacturers will supply a column and set the instrument up for that analysis, so that all the user has to do is connect it and turn it on. Some companies include this service in the purchase price, others charge a fee.

The chromatograph has plenty to do in the fields it has already conquered. Market-research experts of the instrument companies feel that present markets are far from saturated. But some of the new developments such as direct control seem to offer the possibility of a big extension of the fields of applicability. The incentive is certainly there.

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Here Are the Points to Consider When Designing a Solids Pipeline

Physical Characteristics of the Solid

- Specific gravity.
- Friability, grindability and attrition rate.
- Particle shape and size—effect on settling rate.
- Screen analysis—before and after grinding.
- Characteristics of fines in suspension.
- Wettability.
- Solubility.
- Chemical stability in air and/or water.

Physical Characteristics of the Slurry

- Apparent viscosity and specific gravity at various densities and size ratios of solids.
- Effect of temperature and pressure (solubility, apparent viscosity and specific gravity).
- Effect of agitation—thixotropic characteristics.
- Hydrogen ion concentration.
- Gases in suspension.
- Chemical stability of slurry.
- Friction head or loss at various velocities, densities and size ratio of solids.
- Critical or minimum velocity for various densities and size of solids.
- Angle of repose of solids in slurry.
- Rate and degree of separation (dewatering).

Design Data

- Total distance solids are to be pumped.
- Topography of route between terminals.
- Quantity or rate of transporting solids.
- Quantity and quality of water available.
- Power required to pump slurry.
- Spacing between pumping stations.
- Maximum or optimum desirable pressure, both pumps and pipeline.
- Type of pump and drive best suited for optimum service conditions.
- Availability of equipment best suited to pump specific slurry.
- Erosion rate at various densities on: pipe, pumps, preparation and drying equipment.
- Chemical treatment required to: minimize corrosion, friction loss, dewatering and drying costs; clean drying plant effluent (water).
- Flushing and/or drainage facilities.
- Dampening and surge requirements.
- Storage and reclaiming.

Pumping Solids Through a Pipeline

Although there's been a great deal of recent activity in this field, the technique of pipelining solids isn't new. Here's the background on what's been done, where and when.

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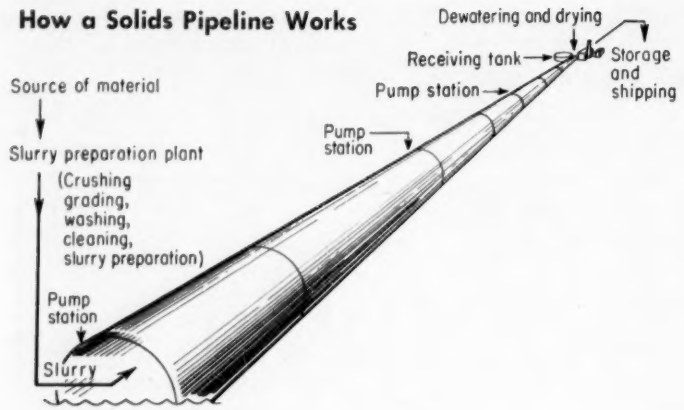
PUMPING solids through a pipeline isn't new. However, neither is it as universal as pumping homogeneous fluids like water, natural gas, crude oil or petroleum products. Principal reason is: it's much more difficult to do successfully and, until quite recently, other means of transportation were more economical. This is true not only for coal but several other bulk solids.

Many proposed pipelines for transporting solids, while technically feasible, were not sufficiently attractive economically to warrant the financial risk involved. In some instances, the difference in transportation cost was negligible. In others, the threat of pipeline competition resulted in a reduction of the prevailing rates on existing transportation facilities to the point where the pipeline was no



longer economically justifiable. In still others, a competitive product was cheaper.

Records of Original Adaptations

Earliest date of record of solids transported in a pipe was in the late 1850's in Calif., in hydraulic or placer mining operations. Where there wasn't enough elevation for washing gold-bearing gravel directly to the sluices—which separated the gold from the sand and gravel—hydraulic elevators raised the water and gravel to a higher level. In these elevators, water under pressure forced the material up through a pipe, from 30 to as much as 55 ft., to the desired elevation where it discharged into a flume or sluice.

Cassiterite, a tin-bearing ore, was similarly pumped in elevators in Malaya prior to 1900. There are records of other installations in Nigeria and Swaziland, South Africa, and in New Zealand about the turn of the century.

According to Peele's "Mining Engineer's Handbook," flushing, sometimes called slushing or silting—the pumping of anthracite culm (fine waste material) through pipes into the worked-out portion of a mine—was first done in 1884 in Pennsylvania for extinguishing a mine fire. It's still done today to reduce and regulate surface subsidence.

Prior to 1900, F. E. Duckham was granted a patent in England on a method of pneumatic transportation of solids for unloading coal and grain from the holds of ocean-going boats. In the U. S., his invention was known as the Darley system.

About the same time, sand and gravel dredges were introduced into the U. S. from New Zealand where they were used in placer mining.

Patent Applications and Claims

Earliest U. S. patent claim for pumping solids through pipes was made by W. C. Andrews of New York. His application, filed Mar. 26, 1889, described his: "intention to take fine coal at the mouth of the coal mines . . . and transport it through (a) pipe . . . distances of . . . hundreds of miles to towns and cities." He even specified "grinding or crushing the material . . . too large or of too great a specific gravity . . . to be carried by the momentum of the liquid, (then) introducing them into the running stream (of liquid) and, finally, separating the same from the liquid at the place of destination."

He was granted Patent No. 449,-102 in Mar. 1891 and is reported to have exhibited a model of his invention at the Columbian World's Fair Exposition in Chicago in 1893. No record could be found of any commercial application of his invention during the life of his patent, or of any attempts on his part to extend the expiration date by subsequent claims for improvements in the application of his process.

In December 1904, W. T. Donnelly of Brooklyn applied for a patent on "an improved apparatus and method for transporting solids, particularly . . . coal."

The method he described was basically the same as Andrews. His "improved apparatus" was primarily an attempt to implement Andrews' feed hopper by automatically "controlling the relative quantities of water and solids materials." Donnelly was granted a patent in July, 1906 but the records don't indicate he was any more successful in exploiting his invention than Andrews.

First Commercial Utilization

First commercial application of hydraulic transportation of solids in a pipe was in 1914 in England by G. G. Bell, a British power plant engineer.[1] He had the problem of getting coal from barges on the Thames River to his boiler plant, less than 1,500-ft. away as the crow flies.

No direct route was available for wagon haulage or for any then common type of mechanical conveyors. He ruled out pneumatic conveyors as uneconomical for lump coal for that distance. Intervening streets and many residential buildings separated the power plant from the river.

After some experiments with sludge type centrifugal pumps at the power plant, he built an 8-in. cast iron, bell and spigot pipeline, 1,750-ft. long from the docks to the power plant.

More Commercial Applications

In the late 1920's, this author designed and put into operation near Mt. Carmel, Pa., a pumping and pipeline system for anthracite sludge—both coal and refuse—the underflow from a Dorr thickener ranging from 40 to 65% solids. Sludge was transported to a waste bank approximately 1 mi. away from the thickener.

In the early 1930's, with the advent of the various hydraulic coal-cleaning plants, called washeries (Chance, Hydrotator, Rheolaveur, Menzies, etc.), it became common practice to pump the fine refuse to a silt bank. In 1938 the St. Clair Coal Co. near Pottsville, Pa., crushed all the refuse from their anthracite breaker and pumped as much as 190 tons/hr. as a 15 to 20% slurry through a 14-in. pipeline almost 1 mi. to behind a settling dam on the mountainside.

In 1934, Ford, Bacon & Davis built for Solvay Process Co. a 15-mi., 12-in. cast iron pipeline in

Louisiana transporting approximately 500,000 tons/yr. of salt in the form of a saturated brine.

In 1937, a feasibility study was made for a similar 55-mi. line located in New York. In both cases the customer used the salt as a brine in his process so it wasn't necessary to dewater and recrystallize the salt. In the latter case, design work was practically completed and options obtained for a good portion of the right-of-way, when in 1939 the railroads reduced their tariff on rock salt to the point where the return on the investment wasn't sufficiently attractive to construct the pipeline.

In 1947 and again in 1957, the economics of this pipeline were reexamined for larger capacities. Although investment/ton of pipeline capacity has doubled in the 20-yr. interval, freight rates, mining and handling costs of rock salt have increased enough so the pipeline may be built in the near future.

Some time in the mid-1940's, the French built and are still operating a 15-in. pipeline about 6-mi. long, through which they pump a 25% solids, minus ¼-in., coal washery sludge at 7 to 10 ft./sec., to a powerhouse where it is dried and burned in the boilers.

Phosphate matrix—a mixture of phosphate rock, sand and clay with lumps up to 6 in. by 9 in. long—has been pumped[2, 3, 4] from open pit mines to washeries since the early 1930's. There are now 20 or more of these pipelines (in Florida alone there are 15), through which over 30 million long tons are pumped annually.

Most of these pipelines are 16-in. dia. spiral-welded, abrasion-resistant steel and are from 1 to 5 mi. long. Those pipelines over 1 mi. in length usually have intermediate booster pumps.

Normally about 600 tons/hr. of matrix are pumped with some 7,000 gpm. of water. This produces a velocity of 10 to 15 ft./sec. while the ratio of solids to liquid varies from 20-40%.

In 1949, Virginia-Carolina Chemical Co. built a 5-mi., 14-in. pipeline to pump 150 tons/hr. of phosphate pulp (minus 8 mesh) from their mine at Clear Springs, Fla., to their Phosmica Plant.[5]

In 1950, the Thiele Kaolin Co. at Sandersville, Ga., built, and is still operating, a 10-mi. pipeline through which they pump a clay slurry from mine to plant.[6] Kaolin is crushed, cleaned and sized, mixed with water, pumped, and at the end of the line, dewatered. There is only one booster pump in this line. It's automatically started and stopped by instruments that also control pH and specific gravity of the slurry.

In July 1951, the Bureau of Mines issued *Report No.* 4799 "A Survey on the Hydraulic Transportation of Coal." In it, the author, R. W. Dougherty, described studies made by Allen-Sherman-Hoff, Koppers Co. and Roberts and Schaefer and went into considerable detail about the technical problems involved. Also presented, are estimates of construction and operating costs.

Conclusion is: "Coal may be transported economically in pipelines, especially in large tonnages to supply a steady industrial market." Also: "before a commercially successful coal pipeline could be designed and built, many more actual pump performance data must be accumulated . . . (quantitative) erosion of pipes and pumps (must be determined), and degradation of coal, economical linear velocities, pressure drop in lines (established) for each coal mixture—and also pumps will require much more development."

In September 1951, International Nickel Co., Ltd., at their mines in northern Ontario, Canada, started transporting nickel-copper concentrates through 8-in., and mill tailings through 13-in., I.D. woodstave pipelines. Two of each size and a 6-in. water line were installed, totaling over 40 mi. of pipe.

To maintain a favorable slope of at least 1%, International Nickel built over 12 mi. of wood trestles to carry these pipes across valleys. Concentrates are pumped about 7½ mi. from Creighton to Copper Cliff and the tailings a couple of miles further, a total of 30,000 tons/day. Velocity of the slurries varies from 5 to 6 ft./sec. and solids concentration from 30 to 50%.

In November 1951, *Coal Age* in an article "Moving Coal to Market" compared the then current costs of what they called the "Old Methods: by Rail, Water or Truck" with "New Methods: by Pipeline, Cross-country Belt or Pipeline Gas." In the section "Coal by Pipeline" they described the plans of Pittsburgh-Consolidation Coal Co. to build a pilot plant and quoted the Bureau of Mines report and cost estimates. Conclusion was: "for a good many years to come, the bulk of the coal shipments doubtless will keep on moving by rail—not because it is cheaper (water transportation is the cheapest but is limited as to availability)—but because it would take a long time and lots of money to build another transportation network that would equal the railroads."

What did *Coal Age* mean by "for a good many years to come" and "it will take a long time"?

In Consol's case it took nine years from original conception to established commercial operation.

In the meantime many other pipelines were being built for transporting solids. A 6-in. pipeline was suspended across the Snake River in Idaho in 1952 to convey a limestone slurry. Started in 1953, anthracite silt is dredged from the Susquehanna River near Harrisburg. It's pumped at 235 tons/hr. through a 12-in. pipeline from a river dock to the preparation plant on a nearby hill, 275 ft. above the river. Cleaned coal is then pumped about a mile further through an 8-in. line to a dewatering and railroad car-loading plant.

Borax slurries are pumped from mine to preparation plant, and in several places coal or ore is pumped from within the mines up shafts or slopes to the surface.

One such installation is in Bonanza, Utah where gilsonite is pumped at 50 tons/hr. out of the mines and then 72-mi. across a mountain range to a refinery in Colorado.[8] Three different types of pumps are used in this installation. One 70-ft.-long vertical submerged pump takes the ore from a sump in the mine and discharges into five centrifugal pumps connected in series. These push the slurry up the shaft about 900 ft. and then overland another 1,000 ft. to a preparation plant on the surface. There it's screened, crushed, desanded and mixed in the proper concentration for pumping. Reciprocating plunger pumps discharge the slurry at a pressure in excess of 2,000 psig. into the 6-in. pipeline conveying it the 72 mi. to the refinery.

In 1957 Ford, Bacon & Davis built the first long distance "transite" pipeline. It was 14-in. dia. Class 150, pressure-type transite pipe, 27 mi. long for transporting salt as a brine.

In August 1957, the Soviets in

their Coal magazine *UGOL* (pp. 38-40) claimed "the first long distance coal pipeline." An English translation of the article in *Fuel Abstracts*, January 1958, states, in our units of measurement: the length is 38 mi., the pipe dia. 12 in., capacity 220 tons/hr. of minus ½-in. coal in a 38% solids by volume slurry, 4.8 ft./sec. velocity, pump discharge pressure 1,000 psig. maximum. They claimed the pipeline "transports coal three times cheaper than by rail . . . and will release 25,000 coal cars for other services." From the figures in the original article, it appears the pipeline transportation costs are estimated to be about ⅓ the railroad costs, and the quantity pumped/yr. would fill some 25,000 coal cars.

Future Pipelines

Many pipelines have been proposed for handling different solids. Some are now being tried out on a test or pilot plant basis. Some, quite practical for short distances, are uneconomical for longer pipelines. Typical example is the pneumatic transportation of wood chips for about 1 mi. at St. Helens, Ore.

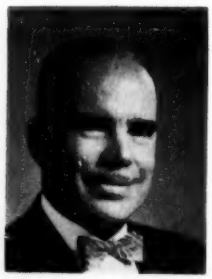
Among the more ambitious of the proposed pipeline projects are:

Transporting wheat from the Canadian prairie provinces to the Great Lakes.

Transporting wood chips in a water slurry over long distances and then near the terminus injecting chemicals into the pipeline and heating a section of it, so the product when discharged is partially pulped.

Transporting 65% solids, nickel-cobalt crystals slurry from a concentrating plant in Cuba into tanks on a boat and then when it arrives in Louisiana, pumping the slurry from the tanks on the boat to the refinery.

Fluffed wood pulp is now being transported in 12,000-ton tankers from British Columbia to Antioch, Calif., and then water is added and it is pumped out of the boat into the paper mill.



JULIAN NARDI has been with Ford, Bacon & Davis since 1935 and their Chief Mechanical Engineer since 1950. He holds a BSME from the U. of Illinois. In the last 24 years, Nardi has assisted on or supervised both the economic studies and the design of many pipeline projects. The feasibility study for Pitt. Consol's coal pipeline and the detail design of the pipeline and pumping stations were done under his supervision.

Technical vs Economic

In the last few years we've made studies of pipelines for transporting rock salt crystals in a saturated brine solution, and limestone, sand, ore, lignite and coal as slurries—for distances from 30 to over 600 mi.

While each one of these proposed pipelines has different and difficult engineering problems, there is always less doubt about technical feasibility than economic. More doubt about the long term adequacy of the supply or the market than the relative cost of transporting or competitive products.

In some instances, processing the solid raw material, to make it into a suitable slurry for pumping, adds enough customer value to the product to offset preparation cost. In other cases, it's just an additional item in the cost of transportation; somewhat comparable to a railroad's switching, yard facilities and return of empty cars.

This processing or preparation of the solids and subsequent dewatering and drying usually cost more, and present more difficult technical problems, than pumping the slurry or building the pipeline. Power required for pumping depends, of course, upon the pressure required to force the slurry through the pipeline. This, in turn, depends upon the topography of the pipeline and the friction coefficient of the slurry in the pipe.

Distance between pumping stations depends upon the maximum acceptable pressure developed at the pump discharge and in the pipeline. This pumping station spacing is also affected by the differences in elevation of the stations and the pipeline.

Look to the Future

A pipeline is more economical than the usual means of bulk transportation, such as barges, railroads, trucks, only when: large quantities, many years of useful life, high annual load factor and relatively long distances are involved. Or, when some unusual or special circumstances exist.

Remember, the cost of preparing the slurry for pumping and dewatering it at the terminal often exceeds the cost of transportation.

Pipeline transportation does have two basic advantages over railroads and trucks: a smaller portion of its operating costs are in labor and materials, both of which are apparently on an upward price trend (spiral); and the cost of returning empty containers is eliminated.

Pipeline transportation of coal or similar bulk solids will not replace railroad transportation as rapidly as it did with crude oil and petroleum products.

However, as railroad tariffs continue to increase, more and more such solids will be pumped overland, especially where water transportation isn't available and where a slurry or fine sizes of the solids are desirable.

Partial processing of a solid while in transit in a pipeline might be the key to a whole new line of products that could be economically pumped through a pipeline.

However, if you are contemplating a solids or slurry pipeline: First, make a thorough check of the economics; then, use all the best technical data and talent obtainable; and last, allow plenty of "lead-time" between the economic justification and the anticipated commercial operation.

This article is based on a paper delivered at the Cleveland Convention of the ASCE, Pipeline and Power Div., May 4, 1959.

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Once You Have the Right "K" Equation Here's

How to Get Numerical "K" Values

In their first article your authors emphasized the importance of standard states. Now, here are the practical applications.

STANLEY B. ADLER and DOMINIC F. PALAZZO, The M. W. Kellogg Co., New York.

MANY expressions for the liquid-vapor equilibrium constant, $K = y/x$, have appeared in the literature of chemical engineering. There are special forms that apply to special conditions such as nonideal solutions, variation of standard state, deviation from the gas laws, etc. This has led to some confusion.

In our previous article (*Chem. Eng.*, June 29, 1959, p. 95) we developed the different forms of K from basic thermodynamics and showed in a summary table how the forms are related. Also, we provided relationships required to work problems simultaneously using different standard states for a two-component system. This is particularly useful when one of the components is above its critical point.

In this article we'll demonstrate in four worked-out examples the practical applications of what we have discussed thus far.

How to Determine Activity Coefficients

Let's consider the case of nitrogen far above its critical temperature in a solution of methanol. To calculate the activity coefficients we find that selection of the standard state referred to infinite dilution avoids most of the difficulty, and that Eq. (17),

$$K\pi\nu_\pi = \gamma_L{}^R f_L{}^R \qquad (17)$$

is extremely useful in working up the experimental data.

Problem—The solubility of nitrogen in methanol at 122 F. has been reported in Ref. 20 (see Table II, next page). Determine the activity coefficients for nitrogen, $\gamma_L{}^R$.

Solution—Using the experimental data and Eq. (17), we've worked out the computations and reported them in Table II. We have used the value $y_{N_2} = 1.0$ throughout because the vapor pressure of methanol is insignificant compared to the total pressure.

A plot of $K\pi\nu_\pi$ vs. x_{N_2}, Fig. 2, gives a value of 55,200 psia. for $K\pi\nu_\pi$ at $x_{N_2} = 0$. And at infinite dilution,

$$\gamma_L{}^R f_L{}^R = f_L{}^R = 55{,}200 \text{ psia.}$$

At all finite values of x_1, from Eq. (17):

$$\gamma_L{}^R = K\pi\nu_\pi/55{,}200$$

We've plotted these values as Fig. 3.

The Gibbs-Duhem equation, which tests for thermodynamic consistency, is often used when the pure component is selected as the standard state for both materials. However, it can also be applied to the case where one standard state is used for one component and a second standard state for the other.

This is particularly applicable when one component is above its critical temperature. Using the subscript 2 for such a substance (the more volatile material) and subscript 1 for the less volatile material, $\gamma_{2L}{}^S$, $\gamma_{2L}{}^R$ and $\gamma_{1L}{}^S$ are shown as lines *PQ*, *KL* and *KM*, respectively, in Fig. 1. Line *PQ* is shown dotted because $\gamma_{2L}{}^S$ cannot be calculated.

Therefore, it will be our objective to eliminate $\gamma_{2L}{}^S$ from the Gibbs-Duhem equation as written for the pure-component standard states:

$$x_1 d\log\gamma_{1L} + x_2 d\log\gamma_{2L} = 0$$

$$\int d\log\gamma_{2L}{}^S = \int \frac{x_1}{x_2}\, d\log\gamma_{1L}{}^S \qquad (18)$$

Let's integrate Eq. (18) between the limits $x_2 = 0$ and $x_2 = x_A$. At $x_2 = 0$, $\log\gamma_{2L}{}^S$ is equal to the distance d, as shown previously in Fig. 1. Then, using Eq. (16) from the first part of this series, the following relationship can be obtained:
At $x_2 = A$,

$$\log\gamma_{2L}{}^R = -\int_{x_2=0}^{x_2=A} \frac{x_1}{x_2}\, d\log\gamma_{1L}{}^S \qquad (19)$$

Examples of systems where Eq. (19) is required in place of Eq. (18) to test for thermodynamic consistency or to calculate activity coefficients are: hydrogen in methane; ethane in propylene; etc. Because the liquid phase can never be 100% hydrogen or ethane in such systems, Fig. 1 has an upper limit at B for the composition of the more volatile component.

We realize that the form of Eqs. (18) and (19) is inexact because it does not correct for the impossibility of a binary system being both isothermal and isobaric

Calculating the Activity Coefficient of Nitrogen in Methanol—Table II

Total Pressure π, Psia.	Cc. N_2 Per Gram of Methanol	Moles of N_2 Per Mole of Methanol	x_{N_2}	y_{N_2}	$K_{N_2} = y_{N_2}/x_{N_2}$	P_R	ν_π at $T_R = 2.53$	$K\pi\nu_\pi$, Psia.	$\gamma_L{}^R$
711	8.7	0.01245	0.0123	1.0	80.4	1.45	1.0	57,100	1.035
1,440	17.4	0.0249	0.0244	1.0	40.9	2.92	1.0	59,000	1.07
2,130	25.1	0.0358	0.0346	1.0	28.8	4.33	1.02	62,700	1.135
2,850	33.1	0.0474	0.0452	1.0	22.1	5.79	1.05	66,400	1.20
3,560	40.1	0.0574	0.0574	1.0	18.3	7.24	1.075	70,000	1.27
4,280	47.4	0.0678	0.0635	1.0	15.7	8.70	1.10	74,000	1.34

For a Mixture of Propylene in Ethane at 160 F.: Data and Calculations—Table III

Total Pressure π, Psia.	y_2	x_2	K_2	y_1	x_1	K_1	$\nu_{\pi 1}$	$(K\pi\nu_\pi)_1$ Psia.	f_{LP1}, Psia.	$f_{L\pi 1}$, Psia.	$\gamma_{1L}{}^S$, Exptl.	x_1/x_2	log $\gamma_{1L}{}^S$
455.3	0.000	0.000	.....	1.000	1.000	1.000	0.705	320	320	320	1.000	∞	0.0
500	0.111	0.062	1.790	0.889	0.938	0.948	0.685	324.7	320	324	1.002	15.129	0.00087
550	0.205	0.130	1.577	0.795	0.870	0.914	0.655	329.3	320	328	1.004	6.692	0.00173
600	0.277	0.199	1.392	0.723	0.801	0.903	0.62	336	320	332	1.012	4.025	0.00518
650	0.330	0.269	1.227	0.670	0.731	0.917	0.59	352	320	336	1.048	2.717	0.02036
...	.....	0.300*	.....	.....	0.700	.....	.....	.....	320	...	1.083	2.333	0.03463
700	0.357	0.338	1.056	0.643	0.662	0.971	0.57	388	320	340	1.141	1.959	0.05729
705	0.350	0.350	1.000	0.650	0.650	1.000	0.565	399	320	341	1.170	1.857	0.06819

Note—Data from Ref. 16. Subscript 1 = propylene; subscript 2 = ethane. * Interpolated value.

Nomenclature

- a Activity.
- A Van Laar constant.
- B First virial coefficient in the equation of state.
- f Fugacity, atm., psia. or mm. of Hg abs.
- H Henry's law constant.
- K Equilibrium constant $= y/x$.
- p Partial pressure of component i in the solution.
- P Vapor pressure, absolute units.
- R Universal gas constant.
- T Absolute temperature, deg. R.
- v Volume of the liquid, cu. ft./mole.
- V Volume of the vapor, cu. ft./mole.
- x Mole fraction in the liquid.
- y Mole fraction in the vapor.
- Z Compressibility factor.
- γ Activity coefficient usually used $= a/x$.
- ν Fugacity coefficient $= f/\pi$.
- π Total pressure, absolute units.

Superscripts

- R Standard state referred to infinitely dilute solution.
- S Standard state referred to the pure component at the temperature and pressure of the mixture.

Subscripts

- L Liquid.
- m Average of values at vapor pressure and total pressure.
- P Vapor pressure.
- R Reduced conditions of P or T.
- V Vapor.
- $1, 2, i$ Components.
- π Total pressure.

as composition varies. However, it is the most common form and serves the immediate purpose of illustrating the use of activity coefficients which are not referred to the same standard state.

Find Gamma for Both Components

Problem—Determine the activity coefficients from the experimental data for both components in the system propylene-ethane at 160 F. Also, check the values for ethane using the Gibbs-Duhem equation. Note that because ethane is above its critical temperature, the pure-component standard state cannot be selected and only the lower concentrations of ethane in the liquid phase are possible.

Liquid-vapor equilibrium data for the system are reported in Ref. 16, and are given in the first seven columns of Table III.

Solution—Let's designate propylene as component 1 and ethane as 2. Values for ν_π for propylene are obtained in the usual way from a generalized chart and the $(K\ \pi\ \nu_\pi)_1$ products are computed.

Next, we calculate values of $f_{L\pi}$ for propylene using this equation:

$$\ln (f_{L\pi}/f_{LP}) = v_m(\pi - P)/RT$$

where v_m is the average of the volumes of the liquid at the vapor pressure and the total pressure. According to Ref. 16, it can be taken as 1.673 cu. ft./mole.

From the equation $K\ \pi\ \nu_\pi = \gamma_L{}^R\ f_L{}^R$, we can obtain $\gamma_L{}^R$ values for propylene. These are plotted in Fig. 4.

How Standard States Change Gamma

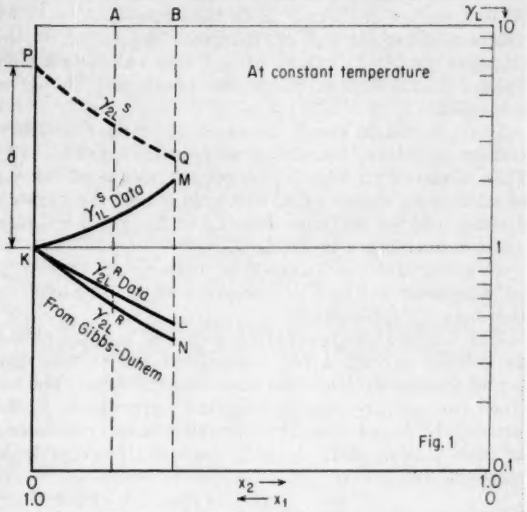


Fig. 1

Activity Coefficients: Propylene-Ethane

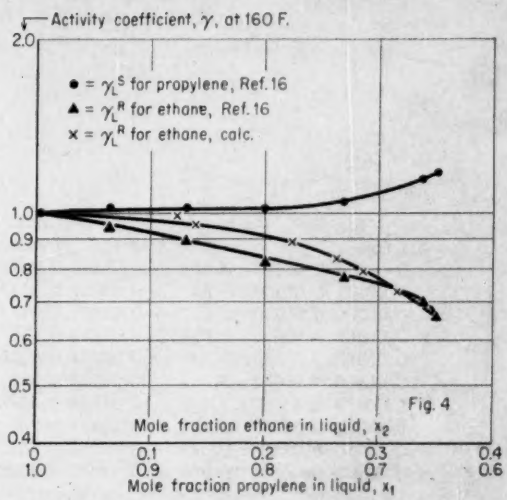


Fig. 4

K Function for Nitrogen at 122 F.

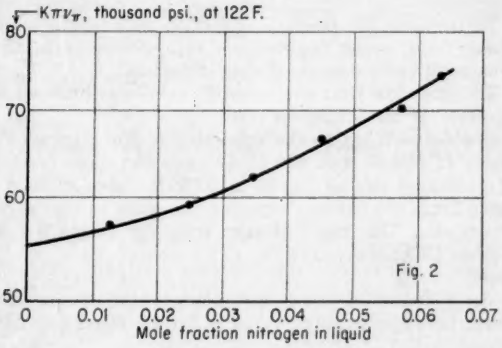


Fig. 2

Gamma for Nitrogen in Methanol

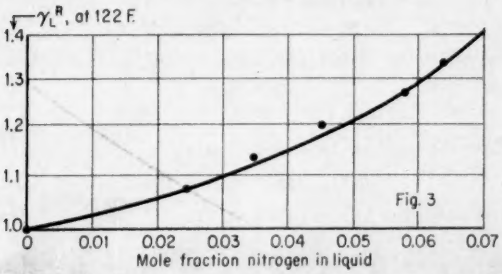


Fig. 3

Gamma for Ethane at 160 F.—Table IV

Total Pressure, π, Psia.	x_2	$\nu_{\pi 2}$	$(K\pi\nu_\pi)_2$ Psia.	γ_{2L}^R, Exptl.
455.3	0.000	.....	...	1.0
500	0.062	0.84	750	0.949
550	0.130	0.815	706	0.894
600	0.199	0.795	665	0.829
650	0.269	0.77	614	0.775
700	0.338	0.755	559	0.706
705	0.350	0.75	529	0.669

Note—Value of f_{2L}^R is 791 psia. for all pressures.

K Function for Ethane at 160 F.

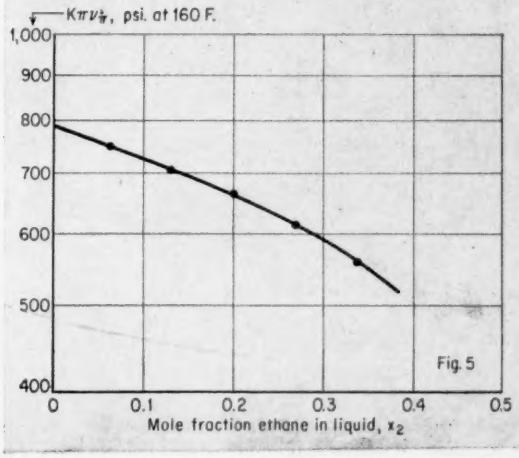
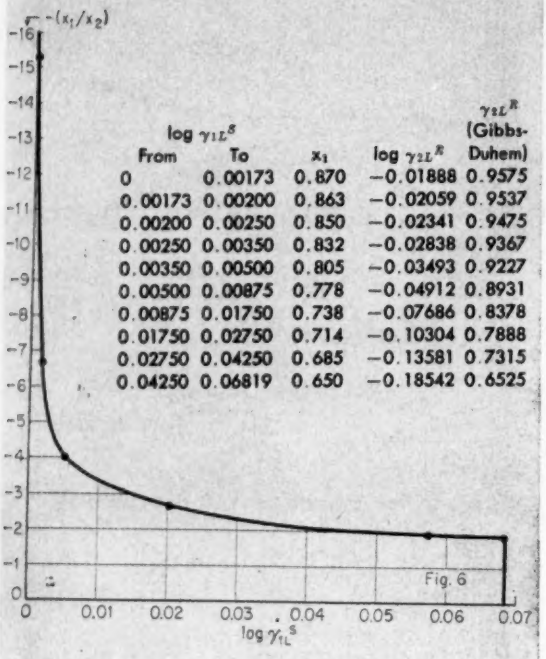


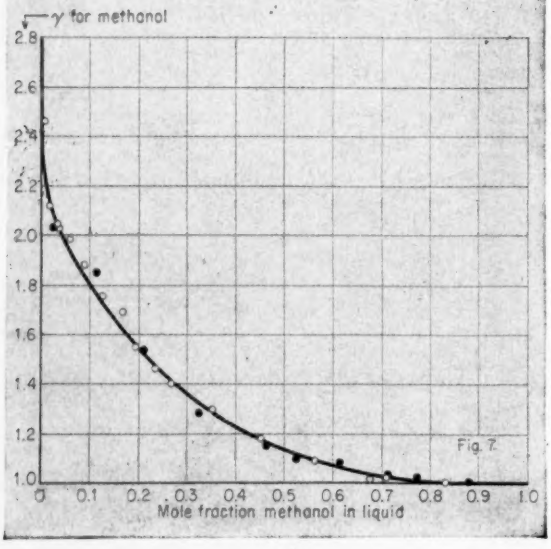
Fig. 5

Graphical Integration of Eq. (19) —Table V and Fig. 6



log γ_{1L}^S From	To	x_1	log γ_{2L}^R	γ_{2L}^R (Gibbs-Duhem)
0	0.00173	0.870	−0.01888	0.9575
0.00173	0.00200	0.863	−0.02059	0.9537
0.00200	0.00250	0.850	−0.02341	0.9475
0.00250	0.00350	0.832	−0.02838	0.9367
0.00350	0.00500	0.805	−0.03493	0.9227
0.00500	0.00875	0.778	−0.04912	0.8931
0.00875	0.01750	0.738	−0.07686	0.8378
0.01750	0.02750	0.714	−0.10304	0.7888
0.02750	0.04250	0.685	−0.13581	0.7315
0.04250	0.06819	0.650	−0.18542	0.6525

Activity Coefficients: Methanol in Water



By using the same procedure applied to nitrogen in the problem above, we can compute $(K\ \pi\ v_\pi)_2$ products for ethane. These calculations are outlined in Table IV and plotted in Fig. 5. Extrapolating to $x_2 = 0$, we obtain a value for f_{2L}^R of 791 psia. Again, as in the nitrogen problem, values of γ_{2L}^R are calculated. See Table IV and Fig. 4, where the points are shown as triangles.

Then, to obtain check values of γ_{2L}^R from the Gibbs-Duhem equation, we graphically integrate Eq. (19). This is shown in Fig. 6. To get the values of log γ_{2L}^R at successive values of x_2, the area under the curve is divided into ten sections. Results of the graphical integration are shown in Table V.

(Values of x_1 in Table V corresponding to the log γ_{1L}^R abscissae in Fig. 6 are determined by cross-plotting the data of Table III.)

The Gibbs-Duhem equation values of γ_{2L}^R are plotted as crosses in Fig. 4 for comparison with those computed previously from the experimental data. The two lines for γ_{2L}^R are not in complete agreement. It was previously found that the thermodynamic consistency of the McKay data is only fair at this particular temperature.

Calculating *K* by Various Methods

In this illustration we'll show how to calculate K constants for a relatively dilute solution at an elevated pressure:

To indicate the possible variation in K value which arises from using the various expressions in accordance with their degree of simplification.

To illustrate that the same K value is obtained regardless of the standard state.

Problem—**What is the predicted K for methanol in water at 392 F. and 280 psia. when the mole fraction of methanol in the liquid is 0.059? Calculate the K value from the various expressions given in this series of articles. Use two different standard states for the liquid. Use an average liquid volume of 0.366 cu. ft./mole.**

As a check on your calculations, you should know that the experimental value obtained by Griswold & Wong in Ref. 7 is:

$$K = \frac{y}{x} = \frac{0.196}{0.059} = 3.32$$

Solution—The vapor pressure of methanol at 392 F. is 600 psia; critical temperature is 924 R.; and the critical pressure is 1,156 psia.

$$\left.\begin{aligned} T_R &= 852/924 = 0.922 \\ P_R &= 280/1{,}156 = 0.242 \end{aligned}\right\} v_\pi = 0.89$$

$$f_{V\pi} = \pi v_\pi = 280(0.89) = 249 \text{ psia.}$$

P_R, based on vapor pressure $= 600/1{,}156 = 0.52$

$$\left.\begin{aligned} v_P &= 0.76 \\ f_{LP} &= P v_P = 600(0.76) = 456 \text{ psia.} \end{aligned}\right.$$

Now we can use this equation:

$$\ln (f_{L\pi}/f_{LP}) = v_m(\pi - P)RT$$

and solve for $f_{L\pi}$, as follows:

$$\ln \frac{f_{L\pi}}{456} = \frac{0.366(280 - 600)}{10.72(852)} = -0.0128$$

When the mole fraction of methanol in the liquid is

0.059, the value of γ_L^s for methanol is 1.95. We have taken this from Fig. 7 which is based on the work of several investigators in the range of 133 to 199 F. (Although Griswold & Wong worked at higher temperatures, let's assume that their results are unavailable, thus necessitating the prediction of K in this sample problem.)

We will now make the usual assumption of a negligible effect of pressure on γ_L, and obtain these solutions to the problem:

1. Correct solution,

$$K = \frac{\gamma_L^s f_{L\pi}^s}{f_{V\pi}^s} = \frac{1.95(450)}{249} = 3.52$$

2. Neglecting the activity coefficient,

$$K = \frac{f_{L\pi}^s}{f_{V\pi}^s} = \frac{450}{249} = 1.81$$

3. Neglecting the pressure correction from P to π of f_L^s by using the value at the vapor pressure f_{LP}^s, gives us:

$$K = \frac{f_{LP}^s}{f_{V\pi}^s} = \frac{456}{249} = 1.83$$

The results of Items 2 and 3 show clearly that neglecting the effect of pressure on the fugacity of the liquid usually does not lead to serious error.

4. Simplifying the solution still further, and using the vapor pressure instead of f_L^s:

$$K = P/\pi = 600/280 = 2.14$$

In this case the P/π method happens to give an answer closer to the correct value than the equivalent forms using fugacities, Items 2 and 3.

However, this is not generally the case. In fact, when one includes activity coefficients the adjusted values are closer to the correct one when they make use of fugacities rather than pressures. (Compare Item 1 with Item 5.)

5. Using activity coefficient and pressure:

$$K = \frac{\gamma P}{\pi} = \frac{1.95(600)}{280} = 4.17$$

It's clear that a *reliable* result at elevated pressure can be obtained only by using $\gamma f_L/f_V$.

6. Rewriting Eq. (4) which Benedict, et al.,[1] presented for the case of 1 atm., in a more general form for elevated pressure:

$$\ln K = \ln \frac{f_{LP}}{\pi \nu_\pi} + \frac{(\pi - P)(v - B)}{RT} + \ln \gamma_L$$

where $B = (Z - 1.0)RT/\pi = -3.76$

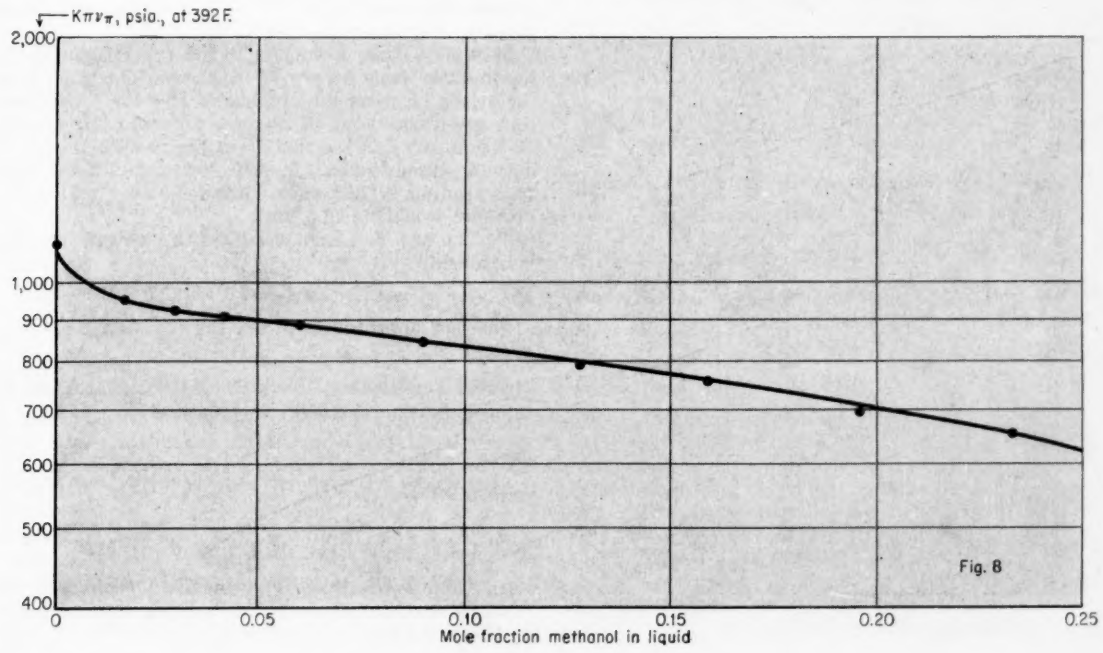
Final substitution in this expression yields:

$$K = 3.09$$

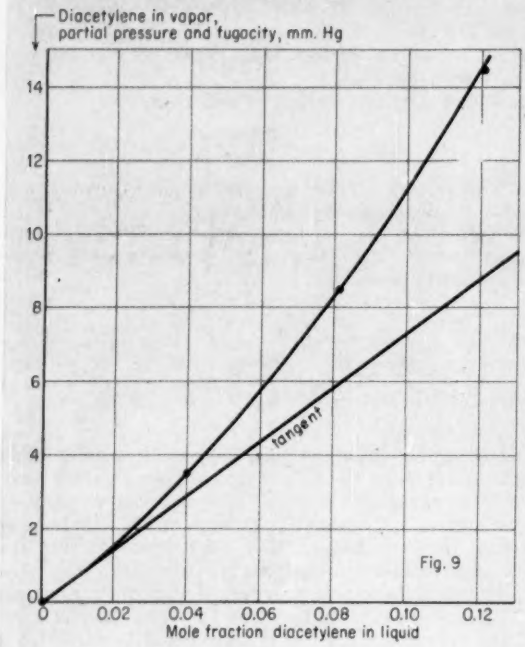
7. Using the standard state referred to infinite dilution. We include the following solution to show that the same value of K can be obtained independently of the standard state selected. Because 392 F. is below the critical temperature, unlike the situations in the first two problems in this article, no advantage exists in using the standard state referred to infinite dilution.

Fig. 8 was prepared by using the procedure outlined in the previous worked-out problems. Let subscript 2

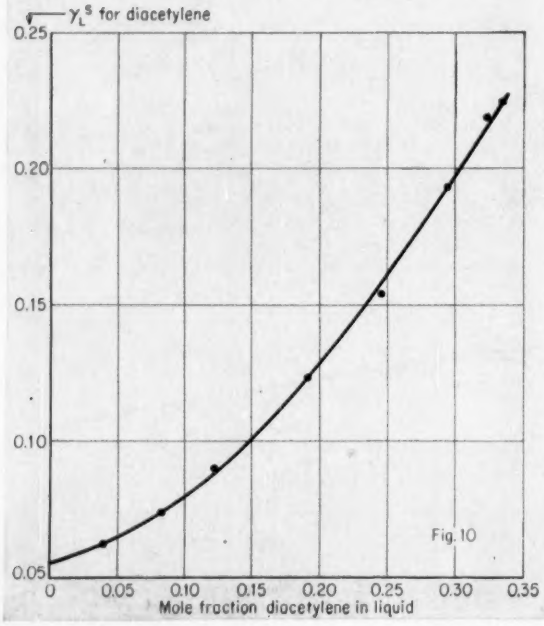
K Function for Methanol in Water at 392 F. vs. Liquid Mole Fraction



Partial Pressure of Diacetylene in DMF



Activity Coefficients for Diacetylene in DMF



represent methanol. Because at infinite dilution $\gamma_{L2}^R = 1.0$,

$$K_{\pi v}, \text{ at inf. dilution} = f_{L2}^R = 1{,}110 \quad \text{(From Fig. 8)}$$

At $x_2 = 0.059$,

$$K_{\pi v} = 885 = \gamma_{L2}^R f_{L2}^R$$

Then,

$$K = \frac{\gamma_{L2}^R f_{L2}^R}{\pi v_{r2}} = \frac{885}{280(0.890)} = 3.54$$

This checks the value of 3.52 in Item 1 above. To illustrate how one activity coefficient can be calculated from another:

$$\gamma_{L2}^R = \frac{\gamma_{L2}^R f_{L2}^R}{f_{L2}^R} = \frac{885}{1{,}110} = 0.798$$

This, in turn, can be shown to be consistent with the value of γ_{L2}^S previously obtained: From Eq. (16),

$$\gamma_{L2}^R = \frac{\gamma_{L2}^S}{(\gamma_{L2}^S)_{\text{inf. dil.}}}$$

From Fig. 7,

$$(\gamma_{L2}^S)_{\text{inf. dil.}} = 2.47$$

Therefore,

$$\gamma_{L2}^S = 0.798(2.47) = 1.97$$

which checks the value of 1.95 used above.

Find Henry's Law and Van Laar Constants

Problem—Phase equilibrium data at 77 F. for diacetylene in dimethyl formamide have been given in Ref. 5. Determine the Henry's law and Van Laar constants. The vapor pressure of diacetylene at 77 F. is 1,336 mm. of mercury.

Because the total pressure does not exceed 100 mm., for the data with which we are working in this case, the partial pressure of the diacetylene can be considered to be equal to its fugacity in the solution, and is plotted this way in Fig. 9. The activity coefficients given in Ref. 5 are plotted as Fig. 10.

Solution—Draw a tangent to the vapor fugacity vs. liquid mole fraction curve in Fig. 9, starting from the origin. Extend the tangent to $x = 1.0$. The intercept gives the value of Henry's constant, H, namely 72.5 mm. We can see this from Fig. 9 even though it doesn't extend to $x = 1.0$, because at $x = 0.1$, the ordinate reading is 7.25 mm. Therefore, at $x = 1.0$, the ordinate would be 72.5 mm.

To find the Van Laar constant, A, we can use this relationship:

$$A = \log (H/P) = \log (72.5/1{,}336) = -1.265$$

Another approach is to use the equation:

$$A = \log (\gamma_L^S)_{\text{inf. dilution}}$$

From Fig. 10 the value of the activity coefficient at infinite dilution is 0.056. Therefore, $A = -1.252$.

REFERENCES

All references in this two-part series have been listed with the first part. Please see *Chem. Eng.*, June 29, 1959, p. 100.

We Tried Our Best, But . . .

In Table I (*Chem. Eng.*, June 29, 1959, p. 97), the heading of Column 4 contains a typographical error: x_i should read x_1.

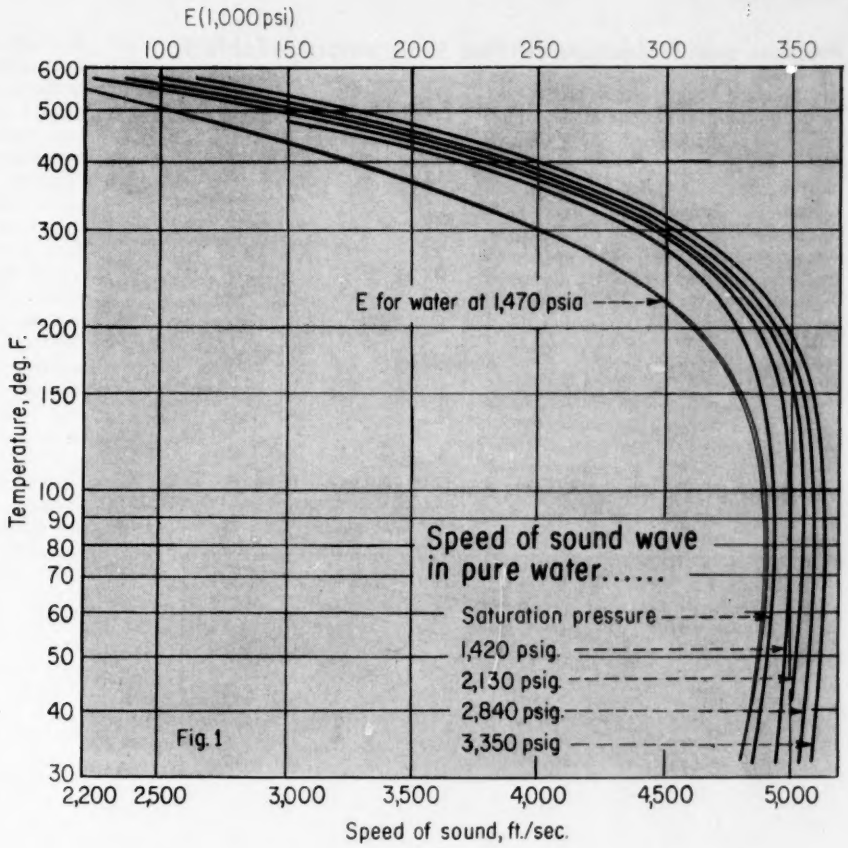


Fig. 1

Beware Sonic Flow

How sonic velocities can affect the chemical engineer's job; What causes such ultra-high-speed flow in liquids and gases; How to avoid the development and consequences of sonic flow.

W. A. ROSTAFINSKI, Arthur G. McKee & Co., Cleveland, Ohio

ALL materials—solid, liquid or gaseous — transmit sound waves. And under certain physical conditions, the velocity of these waves becomes highly significant. Many fluid flow problems, including those pertaining to liquids, require knowledge of speed of sound waves propagated in the fluid. Other applications, especially those concerning gases, require determination of state of the fluid in terms of its thermal and kinetic energies.

First, let's briefly examine the theory of sound waves transmitted in a fluid. Then we'll try to provide several practical ways to judge the cause, development and consequence of the appearance of sonic velocities in liquids and gases.

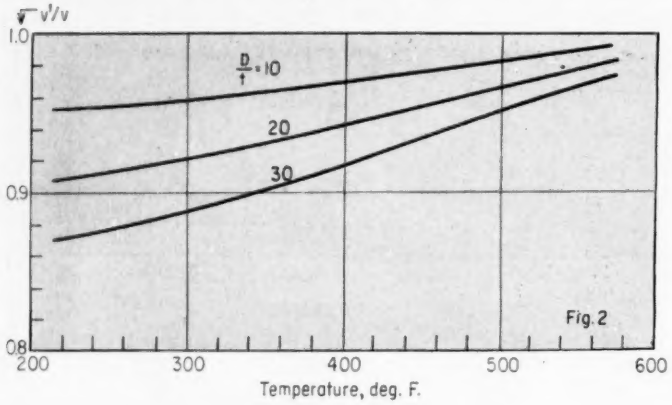
We shall assume that all laws of motion apply so that flow remains in domain of the continuum. Laws of motion are conservation of mass, conservation of energy and conservation of linear and angular momentums. Continuum is range of conditions in which macroscopic consideration is justified.

Matter in motion—molecules

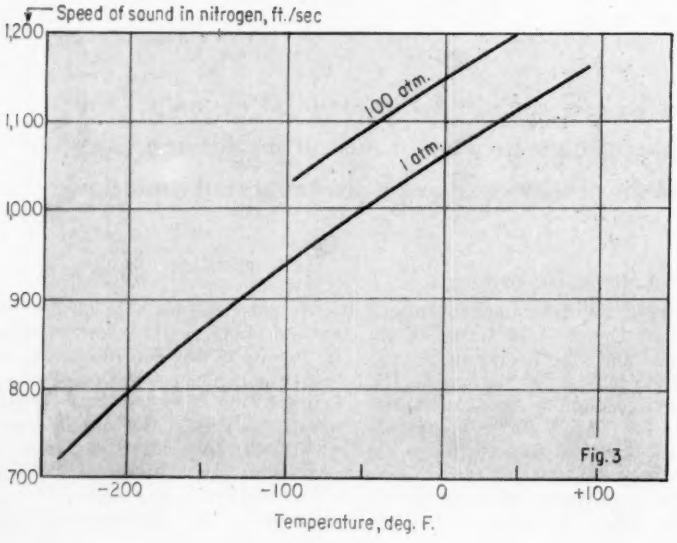
Pressure and Temperature Affect Sonic Velocity—Table I

	Pressure, Atm.	Temperature, Deg. F.	Sonic Velocity, Ft./Sec.
Air	1	68	1,129
	1	212	1,266
	1	932	1,814
	1	1,832	2,297
Air	25	32	1,089
	50	32	1,098
	100	32	1,150
Oxygen	1	32	1,041
Hydrogen	1	32	4,165

Modulus of Elasticity Affects Sonic Velocity



Pressure Increases Sound Speed in Nitrogen



moving in random directions—is a homogeneous fluid with well-defined local velocity. The macroscopic approach applies to eddies of turbulent flow as well as to local discontinuities called shocks. One of the simplest definitions of the continuum criterion is that mean free molecular path for given temperature and pressure of the fluid is small compared with the smallest significant conduit dimension involved. It has been suggested, for instance, that the concept of the continuum is valid if the mean free molecular path of fluid in motion is one-hundredth of the boundary layer thickness.

It may be shown that at high Mach numbers or low Reynolds numbers, the continuum domain can no longer be considered valid. Fortunately, in industrial applications, continuum domain is maintained unless there is high vacuum, very high temperature or flow through a porous medium, where pore dimensions may be of the order of mean free path length.

In fluids, propagation of the sequence of compressions and expansions that forms sonic waves is essentially transient. Fluid viscosity, among other factors, has a damping effect. However, as long as amplitude of the perturbations has detectable magnitude, the effect is sensed, and the period of the wave is little altered. Consequently, sonic wave motion is here considered steady motion, transients of the motion equations being ignored.

Modulus of elasticity E is the ratio of stress to strain.

$$E = -\frac{dp}{dV/V}$$

$$= \frac{dp}{d\rho/\rho} \qquad (1)$$

the minus sign indicating decrease of volume under stress.

From the equation of mass continuity, for any fluid

$$\rho v = \text{constant}$$
$$v d\rho + \rho dv = 0$$

$$d\rho = \frac{\rho}{v} dv \qquad (2)$$

From Euler's equation of the conservation of linear momentum in differential form, we get

$$-dp = \rho v dv \qquad (3)$$

if we neglect the gravity term.

Dividing Eq. 3 by Eq. 2 and making the appropriate substitution in Eq. 1, we finally get

$$v = \sqrt{E/\rho} \qquad (4)$$

A constant must be included to make it dimensionally correct. For most liquids, E varies through a narrow range; however, in liquid petroleum products it varies considerably with temperature and pressure.

Incompressible Fluids

If liquids were not actually compressible, waves could not be transmitted in them. In general, however, liquids are considered incompressible fluids. Their compressibility is relatively insignificant compared with that of gases and often can be neglected.

No liquid, in industrial applications, flows with velocity equal to the speed of sound in the same fluid. A sound wave, in river water at 60 F., moves with a speed in the range of 5,000 ft./sec. Compare this with the jet from a Pelton turbine nozzle —produced by a static head of 4,000 ft.—that moves at a mere 500 ft./sec. In conduits, liquid velocities as high as 50 ft./sec. are the exception. In liquids, we need only consider the propagation of sonic waves in the cases of water hammer, surging and, at times, cavitation.

Water hammer, produced by sudden deceleration of a moving liquid in a pipe, results in a reflected wave traveling along the pipe. This causes sudden, local over-pressures. A wave in a perfectly rigid conduit would move with the speed of sound as calculated by Eq. 4.

Fig. 1 shows the speed of a sound wave in pure water as a function of temperature and pressure. The speed of sound increases with temperature up to about 130 F., then decreases. Also included in Fig. 1 is the bulk modulus of elasticity of pure water at about 1,400 psi. as a function of temperature. The general shape of the sound wave curves of Fig. 1 is governed, as might be expected, by changes in the modulus E with temperature.

No conduit in which water flows is perfectly rigid. The bulk modulus E determines the degree of deformation under stress. Consequently, pipe elasticity reduces the speed of a sonic wave, traveling in fluid, that is suddenly brought to rest. Since E_f and E_p vary with temperature, it's worthwhile to investigate the influence of temperature on wave speed. (Of course, fluid density varies too.)

Nomenclature

(Consistent Units)

- D = Pipe diameter.
- E = Bulk modulus of elasticity.
- E_f = Modulus of elasticity of fluid.
- E_p = Modulus of elasticity of pipe material.
- g = Constant.
- k = Specific-heats ratio.
- L = Pipe length.
- N_{Ma} = Mach number.
- p = Absolute pressure.
- t = Pipe wall thickness.
- V = Specific volume.
- v = Velocity.
- ρ = Density.

Ratio of wave speed at given temperature in an elastic pipe to the wave speed at same temperature in a hypothetical, infinitely rigid conduit is

$$\frac{v'}{v} = \sqrt{\frac{1}{1 + \frac{E_f \times D}{E_p \times t}}} \qquad (5)$$

Fig. 2 shows that in high-temperature water systems the combined effect of reduced E_f and somewhat reduced E_p is reduced wave speed. However, as temperature increases to 500-600 F., this effect almost vanishes.

You might think that less critical conditions would be produced when water temperature increases above 200 F. However, the lower E_p, the lower the permissible safe pressure. In order to limit dangerous over-pressures, closing time of a quick-operating shut-off valve in high-temperature systems must be selected with the same care as for cold water service. (This doesn't apply to relatively short piping runs.) To avoid water-hammer over-stresses, valve closing time should be greater than $2L/v'$.

A few words about cavitation now. The sudden collapse of local vapor pockets is detrimental to life of pipes, impellers and other equipment in which cavitation develops. Cavitation is heard as the collapse occurs. The noise is transmitted to the pipe metal. However, in most cases the collapse of the vapor pocket has only a local effect since the resulting perturbation is a rarefaction, not a compression.

Compressible Fluids

The basic equation for sound wave speed, $v = (E/\rho)^{0.5}$, can also be written $v = (dp/d\rho)^{0.5}$. For gases, there is a distinction to be made between the sound waves propagated isentropically (reversible, adiabatic process) and those propagated isothermally.

For a perfect gas, or for a gas that can be treated as such, $pV = RT$. This relation, suitably combined with the alternative expression for wave speed suggested above, gives for the isentropic case

$$v = \sqrt{gkRT} \qquad (6)$$

The sonic velocity is a function only of the nature of the gas and its absolute temperature.

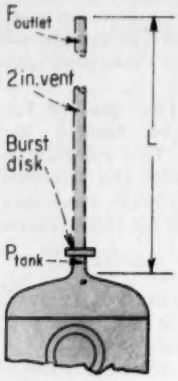
Mach number, a dimensionless flow parameter, is the ratio of actual gas velocity to the sonic velocity in the gas. In subsonic flow, i.e., at gas velocity less than the sonic velocity (as calculated on the basis of the local fluid absolute temperature), $N_{Ma} < 1$. Supersonic flow means that $N_{Ma} > 1$.

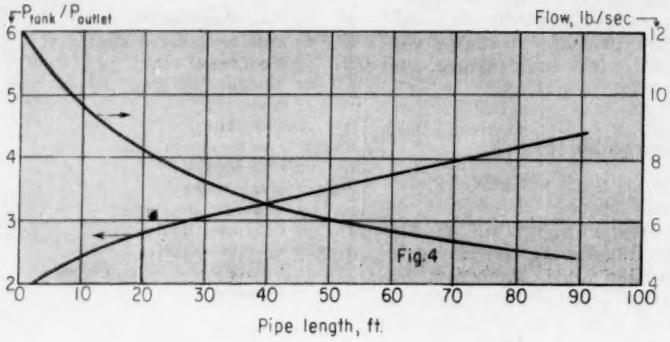
Supersonic flow or at least sonic flow ($N_{Ma} = 1$) is quite common in industrial installations. Some gases, at average conditions, have relatively low sonic velocities. When they flow with relatively high velocities, N_{Ma} can reach unity. Remember, sonic velocity is a well-defined limit in flow of gases in pipes and ducts.

Low sonic velocity is obtained when a gas is of high molecular weight, when its specific heats ratio is low, and when the initial gas temperature is low and falls even lower during flow (adiabatic process). Unless the gas is highly superheated and at moderate pressure (air or nitrogen at ambient conditions, for example), it is not possible to apply the perfect-gas law. The specific-heats ratio ceases to be independent and depends on gas temperature and pressure.

Fig. 3 gives the speed of sound in nitrogen gas. You'll note that these experimental curves show that sonic velocity increases with increasing pressure. Too, at 1 atm. pressure, nitrogen's sound speed experimental curve follows very closely the theoretical Eq. 6. Similar curves for Freon-11, on the other hand, show that for this gas the sonic velocity decreases with increasing pressure. Deviations from the perfect gas law, such as this, cannot be established except by experiment. In Table I, some values of sonic velocity in common gases are given. Note the influence of

Increased Pipe Length Lowers Vent Performance





pressure on speed of sound in air.

In isothermal flow, propagation of the sound wave results in energy dissipation and, therefore, increases entropy of the system. The speed of sound in isothermal wave propagation is always lower than in the isentropic case. Usually isothermal speed of sound finds no application in engineering. Perhaps computations for isothermal flow in very long pipelines should use this flow criterion, rather than approximating with the isentropic case.

Chemical process engineers should be acquainted with the notion of sound transmission in fluids and the consequent problem of sonic velocity. Here's why: In equipment and plant design, flows are considered at their maximum rate, and often some 25% overcapacity is added for future increased plant capacity. In computing heat and material balances and in economic studies, average flow values are used. This works perfectly well as long as moderate pressure changes and temperature gradients are assumed. However, when relatively important pressure drops are likely to occur, or substantial heating or flows through restrictions are predicted, a careful study of the flow at all rate levels may prove fruitful. Also, extreme conditions such as very low pressure, very long piping or near critical-state fluid conditions require serious analysis.

Short Tubes and Nozzles

Isentropic-process (perfect gas) equations should be used to compute flow of gas in short tubes and converging nozzles. Flow will be almost isentropic when the pipe is short enough to assure adiabatic flow and no loss from friction. The specific-heats ratio that is substituted in the sonic velocity expression should be taken from experimental data.

The flowrate of gas, when forced through a nozzle, is limited by the critical-pressure ratio. When pressure at the discharge side of the converging nozzle is equal to or less than about 53% of the pressure on upstream side of the nozzle, sonic velocity is reached at the nozzle exit and flow is at a maximum. If inlet pressure is increased, volumetric flow doesn't increase. (Mass flow increases because density of the fluid is proportional to pressure.)

The isentropic flow in a converging nozzle or short tube illustrates a limitation in gas flow. Isentropic flow does not permit unlimited expansion in a nozzle; nor does it permit any greater conversion of gas internal energy into kinetic energy than that permitted by gas sonic velocity. The first consequence of the existence of a sonic limit is limitation of the flowrate—the choking effect of the critical-pressure ratio.

In many industrial installations the critical-pressure ratio is reached and, therefore, so too the sonic velocity of the gas.

Converging-Diverging Nozzles

Another kind of isentropic flow appears in discharge through converging-diverging nozzles. In practice, flow through such nozzles closely approaches an isentropic expansion and for all practical purposes can thus be considered. Unlike the converging nozzle, however, this type of variable-section passage permits very high gas accelerations. Velocities several times that of sound ($N_{Ma} = 2$ to 5) can be achieved.

At the nozzle throat (minimum-area section), $N_{Ma} = 1$ if pressure ratio across the nozzle is sufficient. In fact, the nozzle portion upstream from the throat is a converging nozzle. Limiting flow through it is that determined by Eq. 6.

At the exit of the diverging portion of the nozzle, there may be supersonic, sonic or subsonic flow. It again depends on the pressure ratio across the nozzle. There is, however, a range of these pressure ratios which produces discontinuities in the gas flow, called shocks, in the diverging part of the nozzle. Within this range, a simple isentropic solution is not possible.

Across a shock, pressure and velocity change suddenly and drastically. A shock is essentially an irreversible occurrence that results in entropy increase and thus in loss of available energy. A shock requires special fluid dynamic handling because isentropic, adiabatic and other flow equations do not assume discontinuities in the flow. The only way to avoid appearance of shocks is to keep the pressure ratio within safe limits predetermined by nozzle design and gas characteristics.

In industrial practice, the ideal theory of shocks is altered by the presence of a boundary layer on the walls of the diverging part of

the nozzle. Depending on divergence angle, nozzle-wall finish and gas velocity, flow can become more or less irregular. A shock—usually only a fraction of an inch thick—can spread over some distance, the pressure change and velocity reduction being less sudden. Venturis, injectors and ejectors constitute the most common application of the converging-diverging nozzle. Of course, the induced flow in ejectors and injectors makes it impossible to apply the above statements in their entirety.

Flow in Pipes

Supersonic flow in pipes never occurs in industrial practice. There is no need for such extremely high velocities. Consequently, only subsonic flow will be considered here.

The most common classification of flow in pipes and ducts is that by mechanical behavior of the stream. Laminar flow is characterized by low Reynolds numbers and uniform, unidirectional motion of fluid. Turbulent motion, in the range of high and very high Reynolds numbers, has multidirectional, eddy fluid motion. Laminar flow presents no problem; velocities are small. Using the continuum criterion, a third kind of flow, molecular flow, cannot be handled by the general laws of fluid dynamics.

The remarks hereafter apply to laminar flow as well as to turbulent, but usually laminar flows will degenerate into turbulent. Only then do critical flow conditions take place. From the thermodynamic point of view, there are several types of turbulent flow. There may be flow with heat exchange (heating or cooling), isothermal flow (at constant temperature) and finally, the most common, flow with friction.

Of course, no flow exactly matches any of these types. For instance, there is frequently friction combined with some heat transfer. Although in fluid flow computations any combination of flow conditions can be handled, it usually simplifies the problem to exclude the less-important factor and base computations on the predominant flow characteristic. For example, it's quite often a good approximation to consider hot air flow in an insulated pipe as flow with friction only.

W. A. ROSTAFINSKI is a mechanical engineer in the Industrial Division of Arthur G. McKee. He studied engineering in Europe and is now at work on a Ph.D. at Case Institute of Technology. His experience includes fluid flow and thermodynamic design.

Flow With Friction

Because of friction, flow in a conduit results in pressure drop, decreasing temperature, increasing velocity and, if the pressure ratio is high enough, $N_{Ma} = 1$ at the end of the pipe. Suppose that the pipe run is made longer. Again there will be $N_{Ma} = 1$ at the end of the extended pipe (sonic velocity lower than the first case), but flowrate will be reduced.

What happens? Friction of the additional pipe length chokes the flow. It's impossible to make a gas flow with sonic velocity in any finite length of pipe, and so $N_{Ma} = 1$ appears only at the very end of the pipe. To overcome additional friction in the extended pipe, some further pressure drop is required and temperature falls somewhat more. Consequently, sonic velocity, velocity of gas and flowrate drop.

As an example, let's consider a variable length tank vent. Assume that tank pressure is 150 psig., exhaust pressure is 14.7 psia., and gas at 140 F., $k = 1.4$, sp. gr. = 1.0 flows with friction only at 8 lb./sec. The entrance to the vent is well-rounded.

Fig. 4 shows the absolute pressure ratio across the vent and the mass flow rate as functions of vent length. With only a nozzle (vent length = 0), pressure ratio is 1.89; sonic velocity is reached at the nozzle exit cross-section. Added pipe raises the pressure ratio but flow remains sonic at the pipe end. Note that added pipe length seriously reduces relief capacity of the vent. Nozzle alone discharges 12 lb./sec.; with 10 ft. of added pipe, discharge drops to 9.6 lb./sec.; and with 88.2 ft. of pipe, flow is limited to 4.9 lb./sec. A vent longer than about 22 ft. will discharge less than the required 8 lb./sec., and pressure will rise in the tank. Lesson is that vent, if too long, may not provide enough relief capacity to protect pressurized equipment.

Flow With Heat Exchange

Flow with heat exchange constitutes a broad and special subject. It may include practically frictionless, slow flows of hot gases in uninsulated pipes and ducts as well as heating and cooling of flowing streams. Cooling reduces gas volume and velocity in pipe; Mach number always decreases. Because of this, flow with cooling presents no sonic velocity problems. Heating, however, can lead to $N_{Ma} = 1$ at the pipe end. When gas velocity reaches that of sound, any additional heat input results in decrease of the gas flowrate; flow is choked by heating.

The choking effect of sonic velocity is especially important in design and operation of centrifugal compressors. Suppose a compressor operates at 100% of rated speed; gas temperature is 520 R., $k = 1.2$, sp. gr. = 3.0. We may wish to use the compressor to handle the same gas but at much lower temperature —say 300 R. We'll assume that mechanical features are adequate for the new operating conditions and that discharge pressure thus developed is acceptable.

Because of the lower sonic velocity of the gas, the compressor handling gas at 300 R. must run at much lower rpm.—at 75% of rated speed in the present example. Higher speed does not produce higher flow and can actually be detrimental to compressor life. The same consideration applies when there is a change in the value of k of the gas or when a gas of different specific gravity is to be compressed.

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Marketing Manager, Chemical Products

W. W. PALMQUIST

Mr. Palmquist was graduated from Yale University with a B.S. in Chemical Engineering. He has spent ten years preparing design proposals, developing new designs and improving existing designs of "Karbate" chemical processing equipment. Based on this extensive design and development background, Bill was made Manager of Sales Promotion and Development for the Chemical Products Sales Department.

For the past year, Bill has been Chemical Products Marketing Manager and is responsible for marketing the complete line of "National" carbon and graphite products and "Karbate" impervious graphite for the chemical processing and allied industries.

He is a member of the American Institute of Chemical Engineers, the National Association of Corrosion Engineers and the Electrochemical Society.

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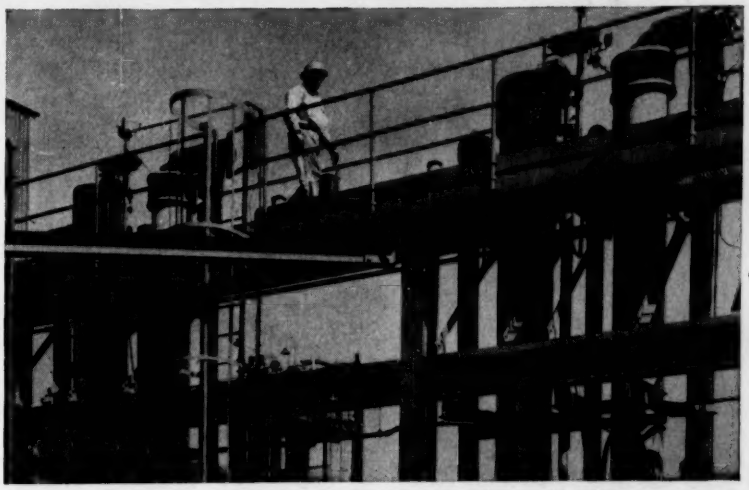

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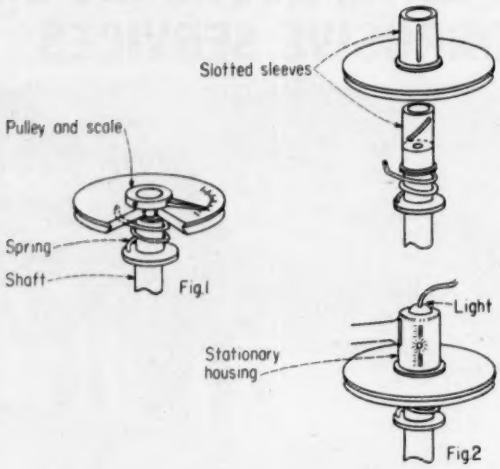
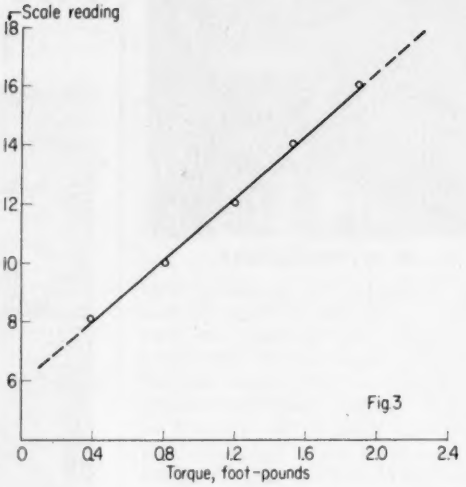
NATIONAL TRADE-MARK





Torsion Dynamometers for the Pilot Plant

In mixing experiments, power taken by the agitator is an important criterion; it's not difficult to build your own torsion dynamometer.

★ **Winner of the June Contest by**

Henry R. Bungay III
Antibiotics Fermentation Development Dept., Eli Lilly & Co., Indianapolis, Ind.

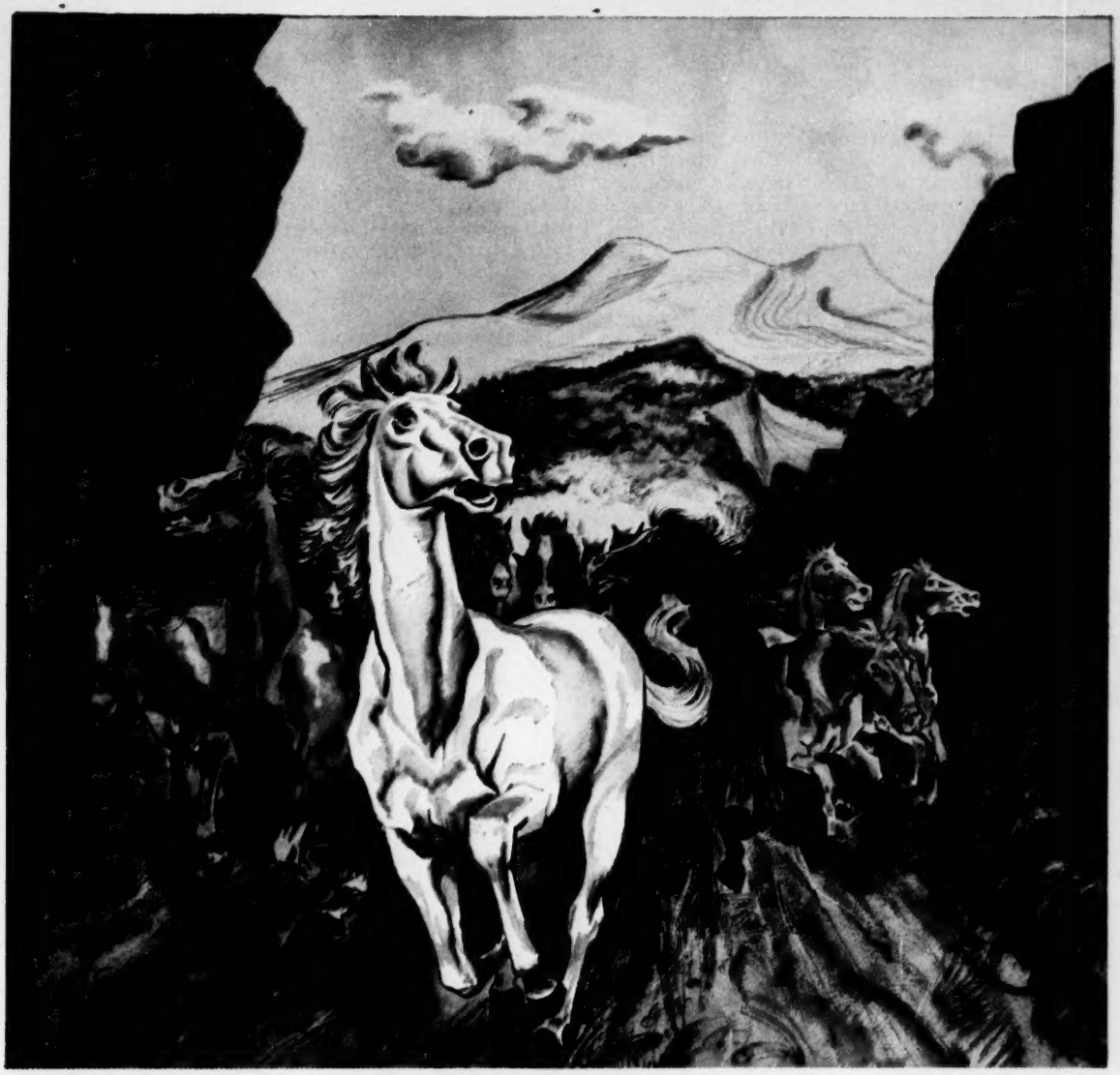
In studying the unit operation of mixing, or such related matters as the interrelation of aeration and agitation in fermentation, it is necessary to know power input to the agitator.

It is easy to determine electric power to the drive motor and this makes a useful way of approximating mixing power, but it is not as accurate nor as reproducible as results obtained with dynamometer measurements of the drive shaft torque. Fortunately, it is not difficult to build a satisfactory dynamometer for small-scale pilot plant work. With the dynamometer calibrated in terms of ft.-lb. of torque, power to the drive is Hp. $= 2\pi$ rpm. $\times$ ft.-lb./33,000.

Nagata and Yokoyama[1] discussed laboratory experiments and the theory and construction of dynamometers. Chemineer* makes a small commercial unit. Another type† senses shaft distortion and can make torque measurements under severe conditions of load, temperature and chemical environment, but is expensive.

The diagram shows two types of torsion dynamometer which we have built for use in our pilot plant. Both are variations of the same basic type. Fig. 1 shows a loose drive pulley mounted on a shaft and connected to the latter by means of a spring. The torque is measured by the amount of twist given to the spring, as shown by a pointer on a scale. To make a reading the

* Chemineer, Inc., 1044 E. First St., Dayton 2, Ohio.
† Crescent Eng. & Research Co., 5440 N. Peck, El Monte, Calif.



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rotation must be "stopped" with a stroboscope.

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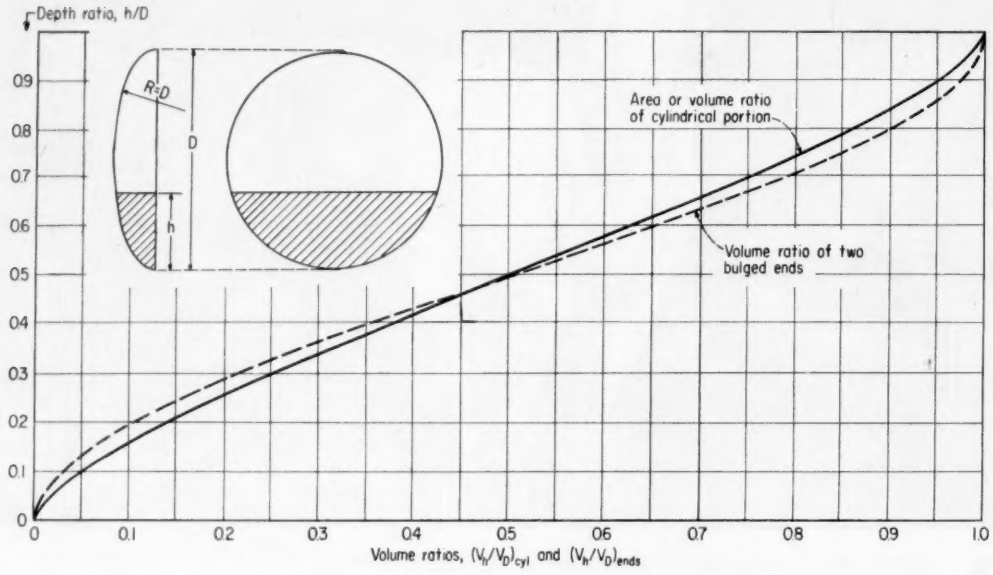
Our 67-liter fermenters are in a well-lighted room where timing lights and stroboscopes are impractical for scale reading so the optical read-out of Fig. 2 was developed. Here, slotted sleeves are attached to the drive pulley and the shaft so that the intersection of the slots is a function of the torque which deforms the spring. A stationary housing with a slot and translucent scale is slipped over the outer sleeve and a light placed within the inner one so that the slot intersection height can be read as it flashes by. Pocock[2] used a somewhat similar principle in a photoelectric torque switch.

Both units have worked reliably with occasional recalibration. Except for limitations on spring size, the same idea can be used for any pulley-driven shaft.

Acknowledgment for assistance and suggestions is due to W. E. Kruse, R. J. Davis, H. A. Clarkson and J. R. Bertram.

REFERENCES

1. Nagata, S., and T. Yokoyama, *Mem. Fac. Engr. Kyoto Univ.*, **17**, No. 4 (1955).
2. Pocock, R. L., *J. Sci. Inst.*, **34**, 459 (1957).



How to Calibrate a Bulged-End Tank

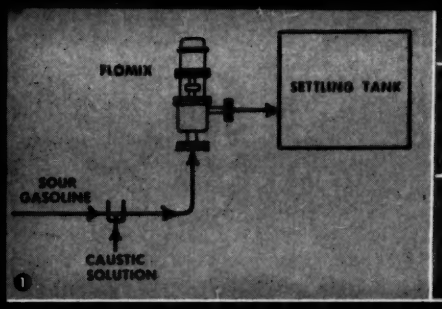
James R. Nichols
Chemical Engineer, Union Carbide Chemical Co., Institute, W. Va.

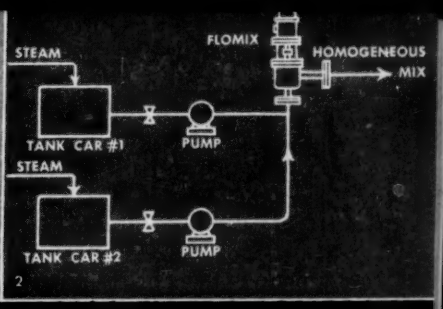
Calibration of horizontal tanks is a very frequent problem in process plants. Many methods have been offered to simplify this problem but in the last analysis they all come down to finding a method of calculating the area of liquid at any depth in a cross section of the tank. To make this information general it is usual to express the area as the ratio of liquid cross-sectional area to tank cross-sectional area, at various values of the ratio of liquid depth h to tank diameter D.

A simplified expression for finding the area ratios for any value of h/D from 0 to 1.0 is given below. The area ratio is numerically equivalent also to the volume ratio for any tank length. The expression is:

$$(A_h/A_D)_{cyl} = (V_h/V_D)_{cyl} = \left(\frac{\cos^{-1} a}{180}\right) - \left(\frac{a}{\pi}\right) \times \sin(\cos^{-1} a)$$

where $a = (1 - 2h/D)$. This equation automatically takes care of liquid-filled segments which are more than half the tank depth. The tank volume for any value of the area ratio is ob-





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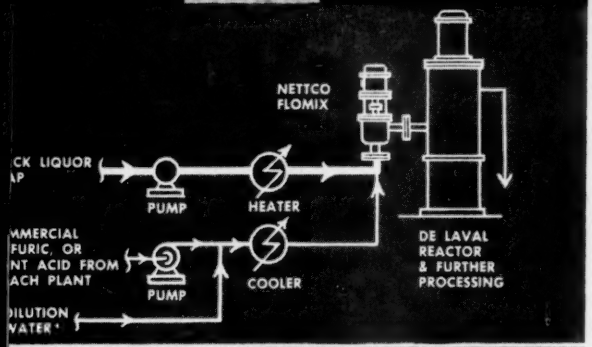

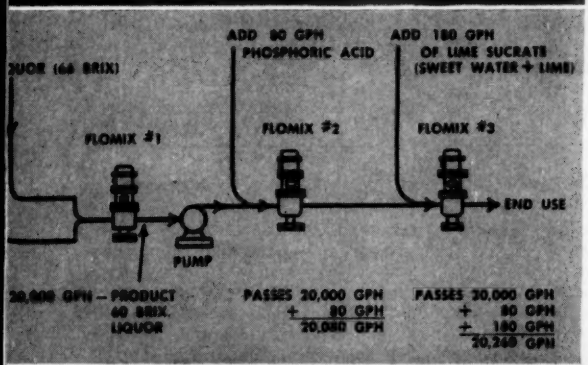

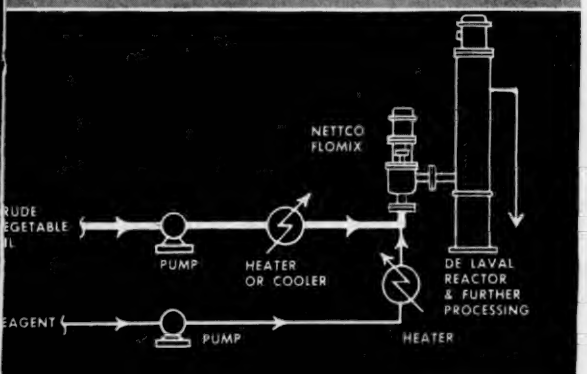

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tained by multiplying by the volume of the entire cylindrical portion of the tank.

The solid curve presents the results of solving this equation for h/D values from 0 to 1.0. Values for this plot can also be obtained at close intervals from a tabulation on p. 32 of the 3rd edition of Perry's Handbook. The A-values in Perry are comparable when divided by $\pi/4$.

Since most horizontal cylindrical tanks have bulged ends, it is also necessary to find an expression for their volume at various depths. Here a volume ratio must be used. The Doolittle formula (Perry, 3rd Ed., p. 1378) can serve as the basis for this expression, which becomes:

$$\left(\frac{V_h}{V_D}\right)_{ends} = \left(\frac{h}{D}\right)^2\left(3 - \frac{2h}{D}\right)$$

This expression gives the ratio of the partially filled volume of a standard bulged end to its total volume. It appears on the chart as the dotted curve. To find the volume for any height h, multiply the volume ratio for that height by the total volume of *two* ends which, from the Doolittle formula, is:

$$V_D = K\,D^3/2$$

where D is diameter in *inches*. If V_D is desired in cubic feet, take K as 0.0001247. Taking K as 0.0009328 expresses the result in gallons.

The chart presented above is general and can be used in calibrating any horizontal cylindrical tank with either flat or bulged ends. However, its exact form is usually not convenient for plant use so it is necessary to decide in what units the final calibration chart or table should be expressed. The tank will most likely be gaged in inches but it may be desired to express the volume in cubic feet, in gallons or in pounds of the contained material.

Then, it may be necessary to correct the calibration for peculiarities of the specific installation. For example, the tank may contain a heating or cooling coil of sufficient size to justify subtracting its volume. Or the tank may be gaged by a pneumatic bubbler-type gage, the dip pipe of which will not reach the bottom so that the indicated head will need correction for the depth of liquid below its lower end. And if such a gage is calibrated in inches of water, its readings will need a density correction if the tank contents has a gravity different than that of water.

To calibrate a specific tank it is best to make a systematic tabulation. This involves selecting a sufficient number of h/D values; finding the corresponding volume ratios for the cylindrical and end portions from the chart; calculating the volumes at the various h/D ratios by multiplying the volume ratios by the full volumes of cylindrical portion and ends; adding the corresponding end and cylindrical volumes; relating these to actual inches of depth; and finally making such adjustments as may be needed—for volume in different units or for weight of liquid, to allow for a submerged coil, or to take care of incomplete submergence of a pneumatic gage dip pipe.

The final result can then be presented as a tabulation of liquid depth vs. tank contents—if maximum reading accuracy is necessary—or as a plot of the same information if reading accuracy is less critical.

General Equation for Pipe Diameter

Philip A. Bryant
Senior ChE Student
Louisiana State University
Baton Rouge, La.

In the usual method for fluid flow calculations, determining the size of pipe for a given volumetric flow and pressure drop requires trial-and-error. However, various approximate equations have been worked out on the assumption of a linear relationship between Reynolds number and friction factor in the turbulent region. Here is another such equation which, for fully developed turbulence, can be relied on to give results within 4% of those calculated by trial-and-error with friction factor charts, using conventional roughness ratios:

$$d = 0.24\,(Q)^{0.382}\,(L/\Delta p)^{0.206}\,(\mu/\rho)^{0.03}$$

Here d is inside diameter of pipe, in.; Q is flow rate, gpm.; L is equivalent length of pipe, ft.; Δp is allowable pressure drop, ft. of fluid; μ is viscosity, centipoises; and ρ is density of the fluid in lb./cu. ft.

The equation was derived by combining the conventional Fanning equation and Reynolds number relationship and putting in an approximate relationship between N_{Re} and the friction factor. The potential error was tested for pipes from ½ to 12 in. at values of N_{Re} from 2,000 to 10,000,000.

NEXT ISSUE: Watch for Winner of June Contest

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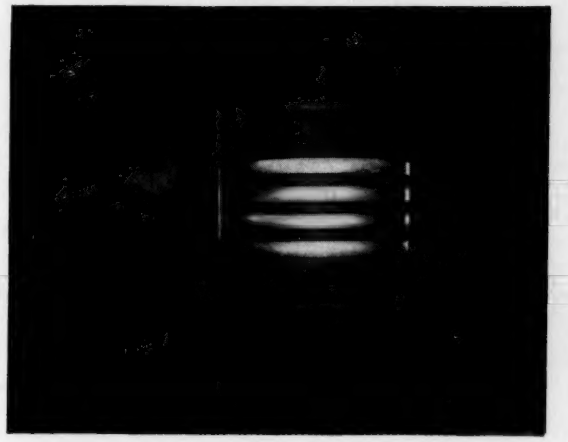
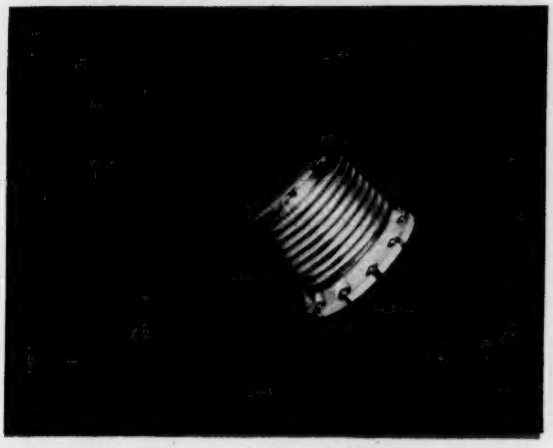
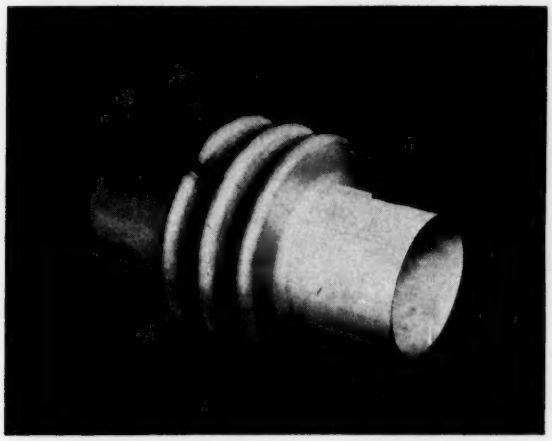
4 WAYS to get maximum reliability in expansion joints



1 Insist that the corrugated bellows be hydraulically formed. The reason is simple. Whenever bellows are formed by circumferential welding . . . whether by edge, seam or fillet welding . . . they will always be subject to premature failure because of stress concentrations at the welds.



2 Be sure the manufacturer maintains a continuous and comprehensive program of endurance testing. This is basic, because of the many variables that affect expansion joint life. Accurate determination of expansion joint life expectancy can only be determined by cycling to destruction.



3 Demand proof that the manufacturer can produce longitudinal welds in the corrugated bellows having the same strength, physical properties and thickness as the parent metal . . . without grinding. A weld that is hard to find is a ground weld. Variations in weld thickness set up points of stress concentration . . . opening the way for premature failure.

4 Check the ability of the manufacturer to supply a team of *competent* design and application specialists to work with your engineers. Check their specific experience in handling critical, complex applications in your field . . . complete to the record of successes or failures behind them, and details of how this experience will be brought to bear on your problem.

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WILL YOU BE HAPPY with your new job? *Pensacola Municipal Adv. Board photo*

Your Next Job: How to Pick a Winner

You can use this engineering formula to calculate in advance your probable chances of holding on to your next job.

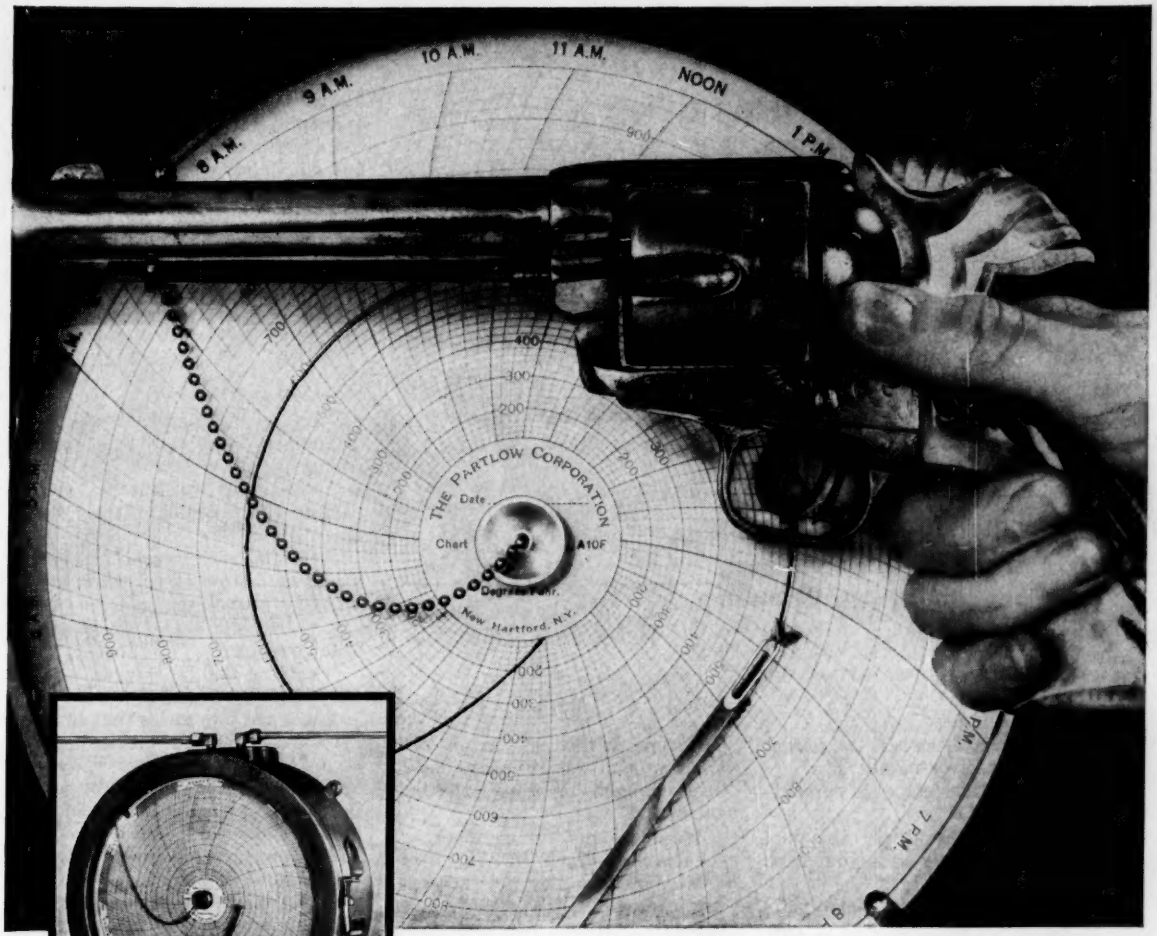
Thomas Garcia-Borras, Chemical Engineer, Texas City, Tex.

Everyone likes to be a winner, whether he is betting on a horse, playing the stock market or looking for a new employer.

The brand-new graduate doesn't have much at stake, as long as he gets some kind of job. If the first job turns out to be a dud, the second is bound to be better. But the older engineer who wants to shift to another job, hoping to find a "better" employer, has to do a lot of soul searching before he puts his chips down on any particular number.

I have developed a formula that will help select your next employer. This formula will be of assistance to you whether you are a new engineering graduate just entering the profession or you are an older engineer. The formula consists of these four rather simple mathematical operations:

- Get the total number of technical people employed by the company in each of the last two years. Add the two numbers together.
- Find out how many technical employees the company has



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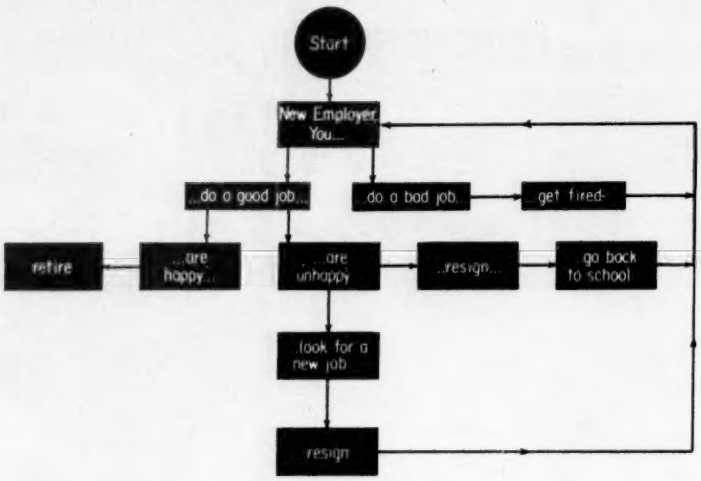

lost in each of the last two years. Total these two numbers.

• Then, calculate the percentage lost.

• Finally, multiply the percentage by four and you have your "quitting odds."

Quitting odds measure your chances of staying with a new employer, if you decide to go to work for him. For example, in a company with a 5% loss of technical personnel, quitting odds are 20%; or the odds are 1 to 4 that you'll be looking for another job soon after you are hired. If the new employer has suffered an 8% loss, the quitting odds are much worse, 32%. This means that chances are 1 to 2 that you'll quit soon after you begin.

Two Basic Assumptions

My formula is based on these two rather reasonable assumptions:

1. Technical employees leaving a company belong, in general, to the group with least seniority.

2. There is more of a chance that an assistant engineer will quit or get fired than the production manager or president of the company.

In this article—now that I've presented my formula and the assumptions upon which it is built—we'll show you how this formula was developed and give you some worked-out, actual examples. Only the names have been changed, to protect the innocent.

We know that our engineering schools have developed their own arbitrary formulas for screening companies that visit their campuses. If last year's, or previous years', graduates send reports back to the campus that such-and-such company is a lousy place to work, that company will not be invited to come back to the campus for interviews the following year.

However, engineers out of school for a few years need a more quantitative approach for deciding whether or not a prospective employer will be a good one.

How Many People Quit?

Few of us have had the nerve to ask this question during a job interview: "How many people quit last year?"

Yet, our whole future with the prospective employer might be tied up in the answer to this single question. Look at the chemical engineering career chart that is outlined above and you'll be able to understand at a glance the necessity for appraising the "quitting odds" during or immediately after an employment interview, and certainly well in advance of accepting a new offer of employment.

Unfortunately, if you don't find out in advance, shortly after you begin work at your new job you might notice that the personnel department is kept busy hiring technical personnel to make up for losses. You'll wonder why people are leaving. And you'll begin to wonder if you will ever leave.

Study the Causes

Direct causes for leaving your department would be included among these five:

• Transfer to another department, or division of the company.

• Going back to school to get a higher degree or to enter the teaching profession.

• Getting a new job with another employer.

• Being laid off.

• Getting fired.

These are the causes that show up on the official employment records. But the records rarely show the indirect causes for losing people such as: poor leadership in the department or group; lack of opportunities; poor working conditions or other frustrations. I know of one chemical engineer who quit a job and took a cut in salary because, "he just couldn't stand the lack of aggressiveness of his boss."

Low Man Leaves First

Looking deeper into the problem, we can see that the people who leave jobs belong, in general, to the group with least seniority and are usually at the bottom of the management ladder. For instance, a large chemical company with about 90 engineers in its engineering department, lost 57 in the last nine years. Average seniority of those lost was four years. Transfers within the company accounted for 31 of the engineers lost by the department. The 26 who actually left the company had an average seniority of 3.4 years; and only two of those who quit were holding positions with more responsibility than the so-called "first line of supervision."

Applying the Formula

With this background we set out to develop a formula that

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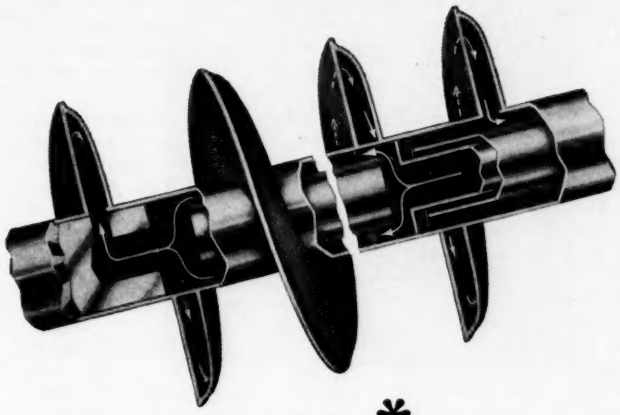

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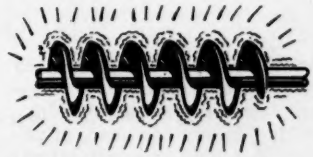

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How to Calculate Your Quitting Odds—Table I

	1957	1958	Total
Technical employees in January	92	108	200
Employees lost up through December	6	5	11
Percent loss			5.5

Quitting odds: 22%, or about 1 to 4

would be easy to apply; easy to interpret; and reliable. We also tried to take into account the fact that in any one year, in addition to people who quit, there are a potential number of "quitters" who are seriously considering leaving. This we know because it takes time to grow unhappy, to look for another job and to start work with a new employer.

This is why average losses for a short period of time would be misleading, especially for small companies or departments. The average for two or three years is more representative. You might be able to spot trends pointing to an improving or a decaying situation.

Why multiply the percent loss by four to get the quitting odds? I decided on this particular factor because dividing the employees into two groups according to seniority, the younger group would show a greater loss, and in computing the quitting odds, the "potential" losses should be added to the calculated actual.

Some Case Histories

In the table above we've worked out the actual figures for the research department of a large chemical company. The figures predict that a new chemical engineer hired in January 1959 may expect that before the year is over five employees out of 50—the lower seniority half—will quit, and five more will be seriously considering leaving. He might also conclude that in 1959, one out of five technical people will be fired by the company, will resign or will begin to look for a new position.

Here's another actual case history. The operating staff of an oil refinery in the Southwest has been decreasing consistently by one engineer per year out of its permanent staff of 25 engineers. This has been going on for the last six years.

Therefore, applying the formula, the quitting odds for a new employee are about 1 to 5, i. e., in 1959 one engineer in the lower half of the seniority group will get out and another will be looking around, seriously, for another job.

In another actual case, a chemical company that employs three engineers and ten chemists loses six to eight professional people each year. A new employee, therefore, has more than a 1 to 1 chance of leaving this company soon after he is hired.

"What's wrong with this company?" you might ask. Well, the salaries it offers are competitive, but one of the severest problems is the lack of recreational facilities in the small town where the plant is located. (Usually though, it's not this easy to find out the real reasons why people leave.)

Table II shows that there is little chance of building a future in a company that has more than a 5% loss of technical personnel. This does not necessarily mean that we can pin down the reason behind the trouble. It might be a noncompetitive salary structure.

But, it might just as well be the location of the plant cafeteria or the company policy on promotion from without.

As a double check, when you compute quitting odds, apply the same formula to the department or even to the particular group that you intend to join. Within a company, some particular sections have a higher personnel turnover than others, and you may wind up joining the worst one.

By thinking in terms of quitting odds, the meaning of the phrase "personnel turnover" becomes clearer. The personnel department might argue that it is impossible to keep everybody happy; that if 8% of the technical staff quit last year, it can be interpreted as 8% unhappy, 92% happy.

On the other hand, Table II shows us that for an 8% loss, one out of three in the lower seniority half of the technical staff is not happy. And that is something for management to be concerned about.

In conclusion, let me emphasize that this formula is not intended as a substitute for thought. You'll have to decide how useful this yardstick is in your own situation.

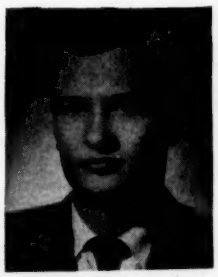
Percent Loss Vs. Odds

Table II

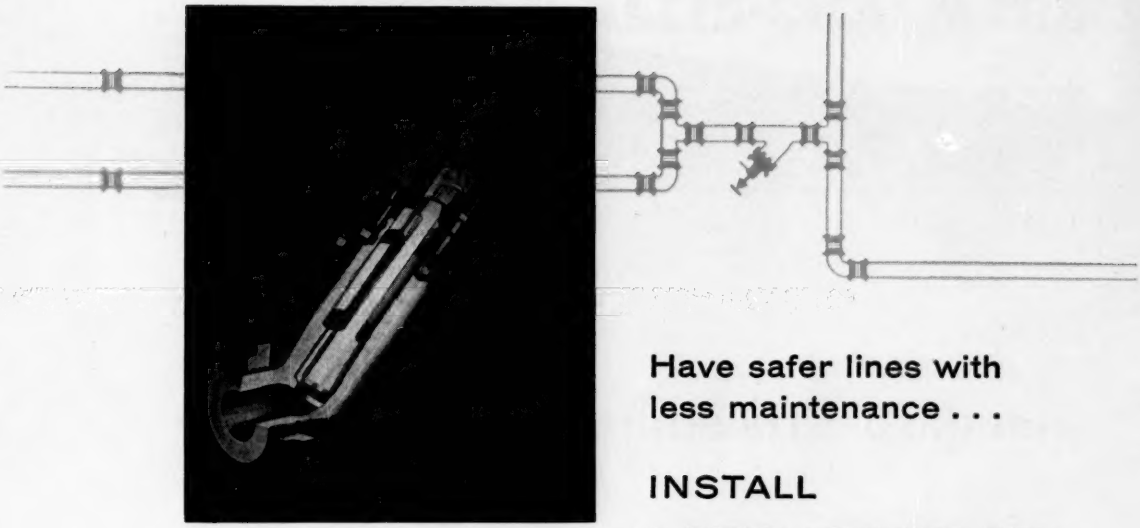
Percent Employees Lost	Quitting Odds
1	1 to 20
3	1 to 7
5	1 to 4
8	1 to 2
10	2 to 3
>13	>1 to 1

Send Us Your Odds

Want to test this formula? Send *CE* your calculations for tabulation on a "no-names" basis.



THOMAS GARCIA-BORRAS was born in Barcelona, Spain, 33 years ago. He graduated in chemistry from the Univ. of Mexico in 1948 and then spent seven years in the Mexican chemical industry. He studied chemical engineering at Rice Inst. in 1955 and is now working in the United States.



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The extra margin of safety essential to many process plants where protection of personnel, equipment and product is vital is assured by the bonding of TUFCLAD fiberglass-reinforced plastic to Lapp Chemical Porcelain. Strong fiberglass fabric is impregnated and bonded in multiple layers to the porcelain with an Epoxy resin of high strength and chemical resistance. It cushions accidental blows—acts as an insulator against thermal shock—and because TUFCLAD is so strong and tough, it will hold operating pressures even when porcelain is damaged by accident. Specify Lapp TUFCLAD Chemical Porcelain and enjoy the purity and corrosion resistance of a solid porcelain system with extra security from TUFCLAD armor.

Y-Valves, as shown, and Angle Valves are available in Lapp TUFCLAD Chemical Porcelain in ½", 1", 1½", 2", 3", 4" and 6" sizes. Also safety valves, flush valves, plug cocks, pipe and fittings (to 8" diameter) and special shapes.

WRITE for description and specifications. Lapp Insulator Co., Inc., Process Equipment Division, 2207 Wendell St., Le Roy, N. Y.

Standard Procedures Aren't Enough

"To gain the essential knowledge of operating equipment, requires almost continuous training, review and mutual discussions between the various technical, maintenance and operating people."

JAMES R. HOWARD, Chief Process Eng., Eagle Point Works, Texaco Inc., Westville, N. J.

We take for granted that standard procedures are absolutely necessary to crystallize thinking on startups, shutdowns and emergencies. However, they are by no means the whole answer.

Have you ever read such procedures? They are usually in outline form, quite long and extremely dry reading. Many an operator has drifted off into day dreams before completing the second page.

The great majority of the operator's time is spent in activities other than those previously mentioned—namely, normal operations. If we assign approximately 4 weeks/year to inspection and test and 1 week to startups and shutdowns, this leaves 47 weeks/year of so-called normal operations.

Of course, we attempt to minimize emergency-type operations and assume here that they are eliminated by the foresight of unit operators, operating supervisors and technical people. Thus, 47 out of the 48 available weeks of operations, or 98% of the time, the procedures used are something other than startup, shutdown or emergency.

Discuss the Problem

Our objective is to develop an organization and techniques that assure each individual operating unit smooth on-test results at the desired and economic throughput. This sounds simple, but becomes rather complicated when you consider the details of coordinating the individual components in a modern plant.

Mechanically, a process plant comprises emergency relief systems, reaction vessels, fractionating towers, accumulator drums, fired heaters, heat exchangers, pumps and compressors, as well as control equipment to keep temperatures, pressures, flow rates, and levels at the desired points.

Unfortunately, each one of these components is subject to various defects with continuous usage, such as becoming corroded, eroded, or fouled to the point that temporary removal from service is required for repairs, cleanup or recalibration.

"Our objective is to develop an organization and techniques that assure each operating unit smooth results at the desired throughput."

To handle the mechanical operations of a unit satisfactorily, operating supervisors and operators must know the equipment and its operating characteristics thoroughly in order to get along at times without portions of it. Essential knowledge of operating characteristics alone can range from pressures below atmospheric to over 1,000 psi., temperatures from 0 F. to above 1,000 F., flow rates from a few gpd. for chemical injections to 60 tons/min. for catalyst circulation.

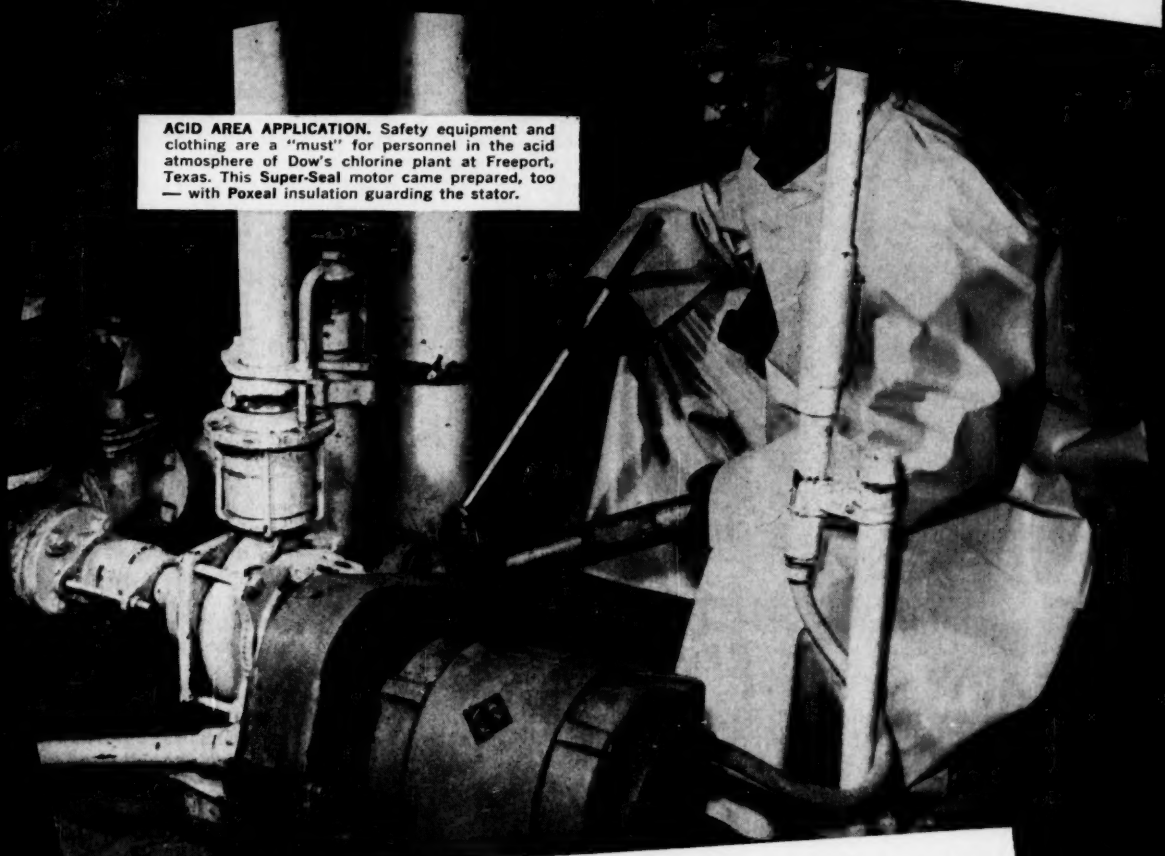
To gain this knowledge requires almost continuous training, review and mutual discussions between the various technical, maintenance and operating people involved.

The days of operating a unit by the seat of the pants have almost disappeared from the industrial scene.

You must create an environment around an operating unit that minimizes or eliminates bad operation. Assuming well-designed equipment, this environment is a blend of cooperation, experience, good judgment, knowledge, analysis, alertness, interest, high standards of performance, clear orders and im-

SCOPE in MOTOR DEVELOPMENT from . . .

ALLIS-CHALMERS



ACID AREA APPLICATION. Safety equipment and clothing are a "must" for personnel in the acid atmosphere of Dow's chlorine plant at Freeport, Texas. This **Super-Seal** motor came prepared, too — with **Poxeal** insulation guarding the stator.

2-YEAR ACID TEST!

Open motor beats enclosed type at its own game

In a tough acid pump installation, Dow Chemical's Texas Division experienced no end of motor troubles. It seemed nothing could stand up in that humid, corrosive atmosphere. Reports Dow: "Even with totally enclosed motors, winding failures were frequent." And, they might have added, expensive.

Then came *Super-Seal* motors — Allis-Chalmers open-type motors with amazing *Poxeal* insulation. A durable case of epoxy-resin encloses the winding end turns and slot portions of the stator . . . the most complete protection ever developed. Result? The *Super-Seal* motor, after two years of continuous operation in the acid area, is as good as ever. So good, in fact, that Dow has ordered 150 *Super-Seal* motors for a new chemical plant at Freeport, Texas.

Isn't it time to revaluate *your* motor standards? There's a good chance that costly enclosed motors are no longer needed. Contact your A-C representative or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

Super-Seal and *Poxeal* are Allis-Chalmers trademarks.

A-1036-C&P

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SUPER SEAL

"98% of the time, the procedures used are something other than startup, shutdown or emergency."

mediate action. These characteristics of the people involved are developed with time and are difficult to legislate by planned procedures or operating manuals.

Foreman-Operator Discussion

Overall quality of work performed by hourly personnel and the safety-conscious attitude developed by them depend to a great extent upon the standards set by the operating foreman and his daily insistence that these standards are upheld.

An organization trained to obtain good results on daily routines will handle major operating changes and emergencies in an acceptable fashion.

Clear, concise, daily instructions to the operators are essential. Preparing these instructions starts with the supervisor of operations issuing daily written general orders that cover desired unit charge rates, cut points, destination of products and product qualities.

If changes are involved from the previous day's operations, the operating foreman outlines, in his order book located at the unit, the manner and timing he wishes used. In addition, the operating foreman covers in his book any special work, such as equipment take-out for repairs, precautionary measures or special check procedures, that each of the shifts should accomplish.

Head operator on each shift signs his initials at the bottom of these orders to indiciate he has read and understood them. In this way the operating foreman has records to show his orders have been read and presumably understood.

Written, daily instructions should be complete, concise, and clear. They should cover why the job must be done, the procedures to follow, safety precautions, use of permits and the time for completion of the job.

Such instructions are much preferred to verbal requests that are supposed to be passed from shift to shift, because in their transmission they become quite garbled. Another reason for written instructions is that supervisory groups assume the men involved are as familiar with the particular problem as they are.

Establish communication between the operators from shift to shift and from the operators to the operating foreman. This is accomplished in the operators' log where the head operator describes work accomplished on his shift and summarizes any difficulties he may have encountered.

This is in addition to each shift checking to see that any operating order requirements, such as charge rates, product rates, reflux rates, stripping-steam rates and product qualities, are being accomplished.

At shift-relief time, relieving operators are verbally brought up to date by the men being relieved on any equipment difficulties as well as failure to meet product specifications or required rates. This gives the relieving operators a chance to ask questions even though this same information is briefly covered in the records.

Other records kept by the operators include still sheets, tank-gage books and equipment books in which such items as leaking valves or special equipment checks are recorded. By these means, continuity of operations (including unusual conditions) from shift to shift is maintained.

Each morning the foreman checks the operators' records and is thus in a position to further investigate, or take immediate action on, any difficulties or failure to follow instructions.

"Our real object is to develop individuals who use their heads in any given situation, emergency or otherwise."

Operating foremen are usually capable men; a large majority of them have graduated from operator ranks after many years of service. They hold these positions for long periods of time and usually have one or more assistants, also from the operator ranks.

All orders issued directly to the operators normally come from the operating foreman or his assistant. The assistants also are men of long experience and are well-qualified to replace the foremen. In this way continuity of experienced direct supervision is maintained—supervision that is steeped in unusual happenings.

Operating foremen have the responsibility of making certain that proper safety precautions are taken before any piece of equipment is turned over to the maintenance forces for repairs. The foreman or his assistant must countersign permits for unheading, entry, hot work or concrete breaking after such permits have been prepared and signed by the operator.

These are permits covering items such as steaming, blinding, gas tests, type of work, restrictions and time limits. Experienced checking and follow-up on safe working conditions is thus obtained.

Technical Force Enters Too

In normal day-to-day operations, the technical forces act in an advisory capacity to the operators, foremen or supervisor of operations, under the direction of plant management.

For instance, the units are checked each day by chemical engineers from the process department. They make recommendations on any changes in operations that appear desirable. Test runs on the whole unit or on individual pieces of equipment are made periodically and analyzed to devise improvements in throughput, product quality or economy.

Also, the process engineers handle a large portion of the classroom training given operators previous to the startup of a new unit. In addition, they may prepare the operating manual for a new unit.

Other technical people, such as

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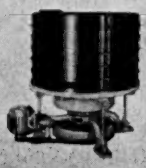
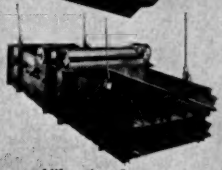
Compacting Mill

Roller-type Granulating Mill



Gyratory Screen



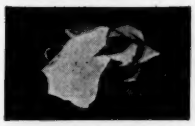
Vibrating Screen

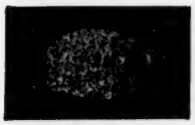
Allis-Chalmers compacting process

Rescues "Lost" Profits

...converts waste chemical fines into a salable product

Plan to stay ahead... MODERNIZE!





A potash producer salvages seven tons per hour from sub-sized fines. A chemical salt manufacturer effects an 80% recovery of marketable material. Yes, waste becomes valuable when put through the Allis-Chalmers compacting process.

The compacting system is a package of integrated Allis-Chalmers equipment — the remarkable new compacting mill, a roller mill and either a gyratory or vibrating screen. The compacting mill mechanically densifies fines created in your original process. The resulting flakes or slabs are granulated in the roller mill and separated in the screen. Precise control of particle size, density and solubility factors is assured. Recovered product equals or surpasses parent product in every respect.

Get Bulletin 07B8836 from your A-C representative or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Canadian Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

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A-5947

the power engineers, work in a similar fashion on mechanical equipment and utilities.

As mentioned previously, any difficulties experienced from an operating standpoint are discussed freely among the operators and technical people as well as with the operating foreman. Real object is to develop individuals who use their heads in any given situation, emergency or otherwise. Display of interest and holding the unit operators responsible for good performance aids in accomplishing this. If an emergency occurs, it is later analyzed thoroughly by all concerned and discussed freely with the operators as to how to handle similar difficulties in the future or how to anticipate and avoid them.

Because we're always trying to improve operations from the standpoint of throughput and product quality, things don't remain static for any length of time on any of our units. We periodically perform test runs, devise new means of increasing throughput by changing flow, bypasses, pump capacity or installing new equipment.

Such changes are discussed freely between the technical forces and the operating people. Operating people are consulted before final decisions are made, and quite frequently they have constructive suggestions to make. At the same time, changes are made in the planned procedures as required and any additional safety procedures are included.

Operators Have Problems

Normally, there's at least a head operator, operator, and assistant operator. Head operator is responsible for making certain that work during his shift is completed in accordance with written daily instructions. The operator normally operates the unit for the control board. Usually, the assistant operator is an outside man responsible for checking on heaters, pumps and the like.

At least twice during a shift the head operator makes a complete tour of the unit to check for leaks, frozen steam tracing lines, or any other unusual condition.

When an inexperienced man is assigned to the operating units, he first learns the assistant operator's job. Some formal training in startup, shutdown and emergency procedures are given him at this time.

"When a real emergency occurs, the operator must analyze the situation immediately and take action. "No manual or planned procedures teaches this, although it does help."

Experience indicates, this type of training is inadequate and continuous day-by-day attention is required from the head operator who stresses safety factors as well as preplanned procedures. Importance of following instructions carefully is also impressed upon the new operator.

Periodically, the supervisor also checks on the new operator to make sure his time is spent in learning planned procedures, as well as obtaining the benefit of the operating experiences of the other hourly personnel.

Together, the head operator and operator cover, with the new operator, emergencies and the effect of changing various operating variables that they have learned over the years.

Dry-run techniques (where the operating foreman poses an emergency-type operation, such as loss of cooling water and then asks each of the operators his proper plan of action) are useful as a follow-up procedure.

This creates quite a beehive of activity for a few days among the uninformed and is a good way to get the operating manuals and planned procedures dusted off. No definite time interval is followed for these dry runs and they are employed possibly four times/year on each unit.

Most of the unit operators exhibit good interest in the job and try to improve themselves by discussing theoretical emergencies or changes in operations with the more experienced operators, their immediate supervisors, or technical people. However, some of the operators don't have this quality and tend to become a fixture on the unit because of long experience.

This latter type is likely to fail to anticipate impending difficulties that are avoidable if they properly followed changes in temperatures, pressures, flow rates and liquid levels. Supervisors must spend appreciable time to improve their performance. Attempts have been made to balance shifts from the standpoint of individual operator quality. This has been found impractical.

When a real emergency occurs, the operator must analyze the situation immediately and take action. No manual or planned procedure teaches this, although it does help. General plans to cover a type of failure, such as loss of cooling water, steam or electricity, and to cover accepted procedures in case of fire can, and should, be developed.

However, when you attempt to cover specific emergencies, the number of possibilities becomes so great that you can't hope to cover all of them.

Some people react in unusual ways during an emergency. Isolated cases have been known of frenzied arm waving, shouting, aimless running about or practically becoming transfixed. These individuals might even be excellent "book" operators.

Good judgment plays an important role in such a situation and, as far as we know, good judgment is usually based on previous work and experience, even on corrected bad judgment.

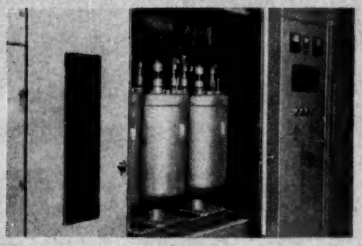
The old saying that mistakes breed wisdom and wisdom begets the knowledge and cunning to avoid future mistakes has application here. Of course, we don't advocate making mistakes to learn how to avoid them, but we do advocate complete discussion of past emergencies or bad operations.

This article is based on a paper delivered to the Refining Division of the API in New York, May 29, 1959.

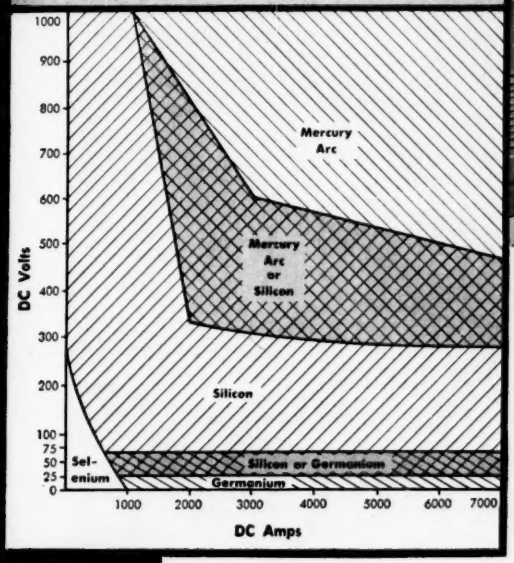
SCOPE in INDUSTRY
SPECIALIZATION from...

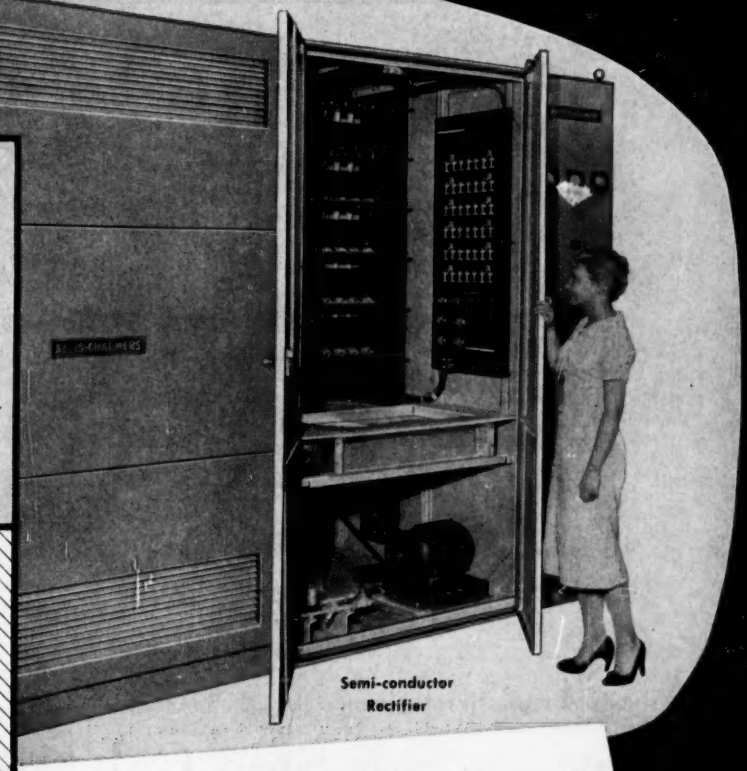
ALLIS-CHALMERS

Open pumped tube Mercury Arc Rectifier



Enclosed sealed tube Mercury Arc Rectifier





Semi-conductor Rectifier

Allis-Chalmers takes the confusion out of power conversion

Right-for-the-job rectifier

Available to Electrochemical Industries

There's only *one* type rectifier that's *right* for your electrochemical application. Use the above chart as a guide. It shows the approximate direct current and voltage ratings that best fit the various types of rectifiers. After checking the chart, check with Allis-Chalmers. Thirty years' experience in developing, building and applying rectifiers equips A-C to analyze your needs and make a pinpoint recommendation.

Allis-Chalmers makes all static types

Allis-Chalmers builds semi-conductor rectifiers such as germanium, silicon, and selenium, as well as mercury arc rectifier units of the pumped or sealed type in open or enclosed construction. Because Allis-Chalmers can supply this wide variety of power rectifiers, our recommendation is always completely unbiased — never influenced by commercial expediency. For complete information, call your A-C man or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. In Canada, write Allis-Chalmers Ltd., Box 37, Montreal, Quebec.

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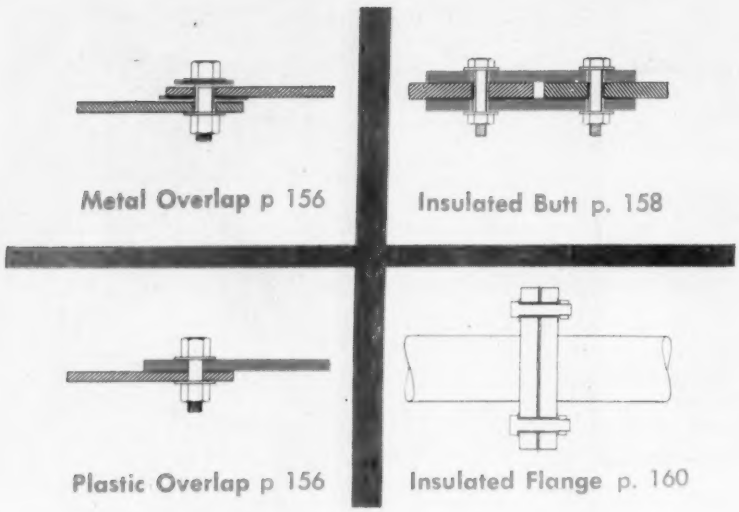

Plastic-Insulator . . .

Designs Side-Step Galvanic Corrosion

Watch out when your design calls for joining two dissimilar metals—galvanic action can make short work of this couple. Plastic insulators will prevent dissimilar metal corrosion.

M. Stander and H.S. Preiser, Bureau of Ships, U.S. Navy, Washington, D.C.

Galvanic corrosion takes many forms and shapes. One serious situation: two dissimilar metals joined together mechanically in a section of equipment and immersed in an electrolyte.

M. STANDER is a materials engineer with the U. S. Navy Bureau of Ships, Plastics and Dielectrics Branch.

H. S. PREISER, consulting engineer, is also a corrosion engineer with the Bureau of Ships in the Coatings and Preservation Branch.

This coupling causes a current to flow from one metal to another. The anodic metal will corrode preferentially to the cathodic metal.

Methods have been developed for avoiding the destructive effects of dissimilar metal systems. But one more point should be made, before discussing these methods. When current produced from an anode flows to a cathode, the voltage of the cathode is raised in the direction of the anode (polarization). In the ideal case, cathode potential could reach the value of the anode potential and galvanic current would cease to flow because of the lack of a potential difference between the dissimilar metals. For the corrosion reaction to continue, depolarization of the cathode must occur. In normal practice, velocity effects in conjunction with dissolved oxygen will remove atomic hydrogen formed at the cathode. Removal of this polarization film will allow galvanic action to continue until serious damage is done.

▶ **Break Circuit**—One solution

Organic Acids Causing Corrosion?

...Test **HAYNES** Alloys

HASTELLOY alloy C and nine other corrosion-resistant alloys were tested in hot acetic acid vapors containing traces of oxidizing contaminants. HASTELLOY alloy C had a penetration rate of only 0.0007 inches per year—lowest among all nine competitive alloys. Others varied from 0.005 to 0.5 inches per year and were severely pitted. This test showed one manufacturer of organic chemicals how he could keep his maintenance costs to a minimum before a process was even on stream.

How much money can you save in your plant? Why not find out for sure by testing HAYNES alloys.

We'll gladly send you samples. There are 6 HAYNES corrosion-resistant alloys. To help us select the one most likely to solve your problem, we suggest that you send us a letter outlining the corrosive conditions in your plant. To learn more about HASTELLOY alloys, ask for a copy of our 104-page book. It describes the alloys in detail.

HAYNES
ALLOYS
HAYNES STELLITE COMPANY

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Union Carbide Corporation
Kokomo, Indiana

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to this problem is to break the metallic circuit of the couple by interposing an electrical insulating material such as plastic. We will confine ourselves to discussing such insulated bolted connections for general construction purposes and point out some applications.

There are, of course, other techniques for getting around the problem. All have specific disadvantages.

Consider cathodic protection, for instance. This technique uses current from an external source to polarize or change existing potentials. It is sometimes difficult to apply cathodic protection to large dissimilar metallic structures which are alternately immersed in an electrolyte. In confined spaces, cathodic protection can be ineffective because it's difficult to place the anodes.

The more common method in use for combating galvanic corrosion is to remove one or both members from the electrolytic circuit with insulating paints. The more impervious paints based on vinyl, alkyd and saran resins, are generally effective in reducing this type of attack but there are several practical drawbacks. Actually, in underwater service, it is difficult to keep the coatings intact due to abrasion and other mechanical damage. Also, degree of adhesion of these paint films depends on cleanliness and pretreatment of the metal surface. Paint usually exhibits more adhesion on the cathode than on the anode—metal solution takes place on the anode through the pores and imperfections in the paint film. This film breakdown at the anode can aggravate corrosion conditions to the point of rapid perforations because of the unfavorable galvanic area relationship.

Insulating with plastics has few of these disadvantages and can be used with other corrosion-prevention methods.

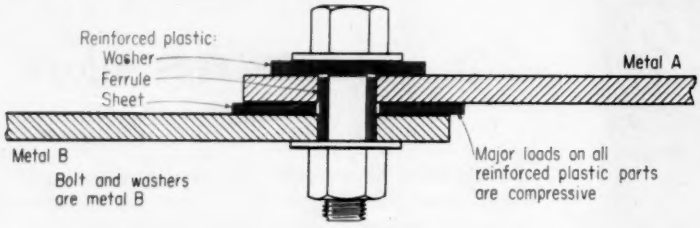
▶ **Electrical Insulators** — Plastics are a logical first choice for use in an electrically isolated joint under load. They have good insulating and strength properties. Because of the varying individual characteristics of different plastics, the following criteria should be considered for the selection of an insulator:

- Ability to withstand long-time immersion in electrolytes without deteriorating either chemically or mechanically.
- Nonreactive when in contact with metals under consideration. The metals or the plastic must not be affected.
- Ability to withstand high sustained load with negligible creep.
- Adequate mechanical strength: bearing, flatwise or face compression, tensile and fatigue.
- Resistant to vibration and high-impact loads.

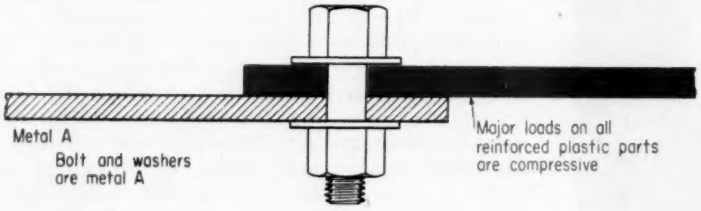
Since the mechanical properties of the insulating material are of prime importance, the first choice in plastics, of course, are the glass-reinforced phenolic, melamine or polyester laminates. Before exploring this further, a simple experiment was run to determine the effectiveness of a glass-reinforced laminate in reducing corrosion.

▶ **Overlap Designs**—In this laboratory experiment, aluminum was insulated from steel with a glass-reinforced polyester strap. Three samples were prepared; one with aluminum lap-bolted to the steel, the second isolated and the third sample the same as the second except that a copper wire connected the dissimilar metals.

For Metal-to-Metal Overlap — **Fig. 1**

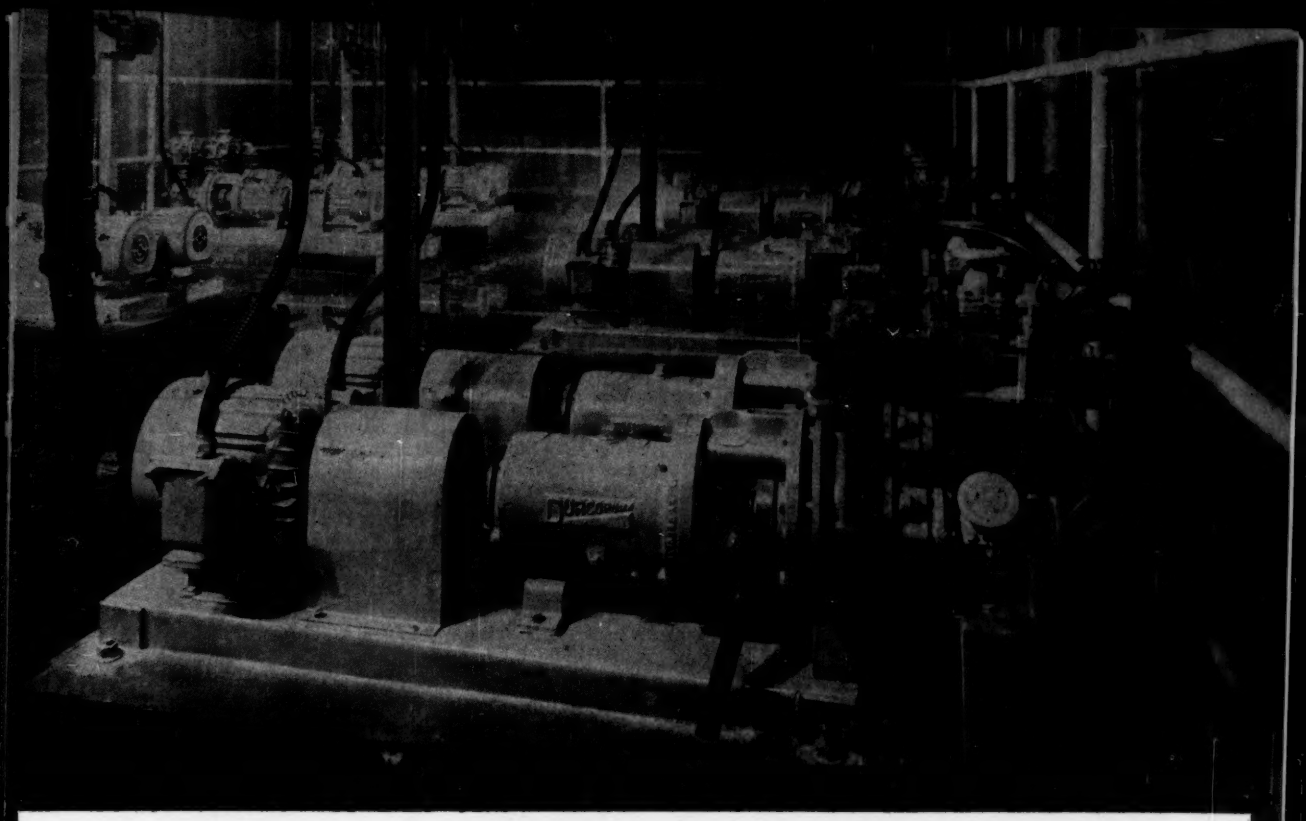


Consider Metal-to-Plastic Overlap Design — **Fig. 2**



How Glass-Plastic Laminates Stand Up to Temperatures, Pressures

Condition of Specimen	Laminate Material	Average Face Compression Strength, 1,000 Psi.
As received	Phenolic	88.7
3 hr. boil (sea water)	Phenolic	80.0
24 hr., 500 psi.	Phenolic	81.0
As received	Melamine	112.4
3 hr. boil (sea water)	Melamine	96.5
24 hr., 500 psi	Melamine	104.9



THIS IS A PUMPING STATION AT CARBORUNDUM METALS COMPANY. HERE ARE A FEW OF THE MORE THAN FORTY SERIES H DURCOPUMPS USED IN THE PRODUCTION OF ZIRCONIUM. THESE PUMPS HANDLE $ZrOCl_2$ TWENTY-FOUR HOURS A DAY, SEVEN DAYS A WEEK. THE AIR IN THIS AREA IS CONSTANTLY FILLED WITH CORROSIVE CHEMICAL VAPORS. EVEN WITH THIS HARD USE AND CHEMICAL ABUSE, DURCOPUMPS REQUIRE AN ABSOLUTE MINIMUM OF MAINTENANCE.

Series H Durcopumps are chemical pumps all the way. They are designed and built to give long, trouble-free life when handling tough corrosives. They have a large, rugged shaft with minimum deflection, heavy duty bearings, integral suction and discharge with casing support. Durcopumps are adaptable to either packing or mechanical seal.

These pumps are available in twelve standard alloys with interchangeable wet end parts. Capacities range from ½ to 3500 gpm, and heads to 345'. When you have a chemicals handling problem, and want long, dependable pump life, call the Durco service engineer.

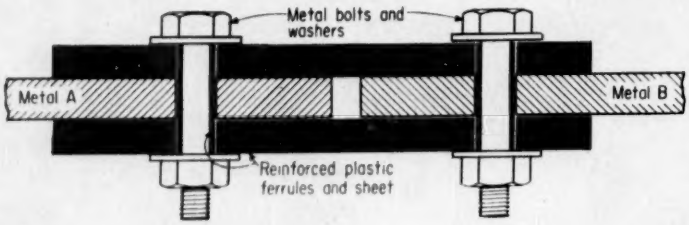
DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

The mark of dependability in tough chemical service . . . everywhere

THE DURIRON COMPANY, INC. / DAYTON, OHIO

Branch Offices: Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Detroit, Houston, Knoxville, Los Angeles, New York, Pensacola, Philadelphia, and Pittsburgh.

Butt Design Avoids Dissimilar Metal Contact **Fig. 3**



Basic designs are shown in Figs. 1 and 2.

These samples were subjected to alternate immersion in sea water and allowed to dry in air. The isolated sample showed normal corrosion of both the aluminum and the steel while the other two samples suffered accelerated corrosion on the aluminum.[1] This was to be expected from the electrochemical considerations involved.

Effectiveness of the laminate in reducing bimetallic corrosion now leads to further consideration of the mechanical properties of glass-reinforced laminates. The properties of greatest interest are flexual and tensile strength, face or flatwise compressive strength and creep, and bearing or edgewise compressive strength and creep.

The table on p. 156 shows results of face (flatwise, perpendicular to laminates) compression tests on glass-reinforced phenolic and melamine laminates. Since the effect of long-term immersion on physical properties is a question, the laminates were subjected to a 3-hr. boil test and submergence test at 500 psi. Results of this test led to the conclusion that appreciable deterioration of these laminates in sea water is not expected to occur.[2]

Effect of long-term bearing pressure (edgewise, parallel to laminations) on the properties of a glass-reinforced polyester laminate was also studied. The results show no appreciable change in deformation for the first 100 hr. and a slight increase after 1,000 hr.[3]

The bearing strength of the glass-reinforced melamines and phenolics is expected to be of the same order of magnitude.

Since the data were obtained on sheet material, investigation of the mechanical properties of plastic ferrules, especially in face compressive strength and deformation was undertaken. Ten samples of glass-reinforced phenolic and polyester laminates (in four different sizes) were tested. Strengths and load deformation curves were of the same order of value for sheets and washers of the same composition. In general, the face compressive strengths of glass-reinforced laminates are several times as high as the bolt bearing stresses commonly used.[5]

Coating of the edges of phenolic laminates with a polyester resin resulted in a considerable increase in wet strength, probably due to reduction in penetration of water into the laminate.[4]

▶ **Effects on Metal**—It was not known what effects, if any, would result when the fastenings of the common structural metals were placed in contact with glass-reinforced laminates and subjected to sea-water immersion. Salt-spray tests on metallic screws set in glass-reinforced phenolic and polyester laminates were made over a six-week period. Results indicated that in no case did the laminate affect the corrosion rate of the screws.[6] The metals studied were aluminum, cadmium and zinc-coated steel. Since these more active metals were satisfactory, the more noble metals such as copper and nickel-based alloys should behave similarly. It can be safely concluded that any corrosion-resistant metal fastener should be suitable for an insulated-joint design.

▶ **Butt Design**—In the joining of glass-reinforced plastic laminates to each other or to other structural members, it is important to consider the effect of edge and end distance on the design. These distances will vary with the type of laminate, angle of loading and the D/t ratio (diameter of bolt to laminate thickness). Within the range of glass-reinforced polyester laminates tested, an end distance of $4D$ and an edge distance of $2\frac{1}{2}$ D will be adequate for all laminates.[7] The stresses at the proportional limit and at the maximum load are considerably greater at $D/t = 1$ than $D/t = 4$. Wet strengths for all conditions are correspondingly lower.

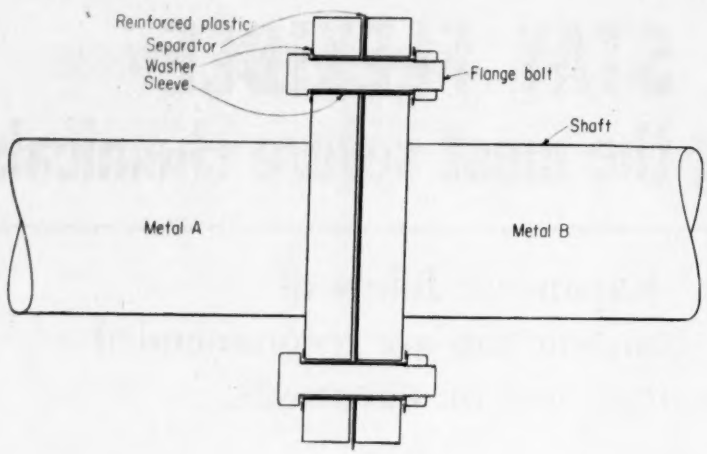
Where stiffness is of concern, a plastic laminate has to be considerably increased in thickness (by a factor in the order of three) to be equal to the stiffness of structural steel due to the low modulus of elasticity of the laminate. It is not necessary to increase plastic thickness very much with a double-strap connection. Fig. 3 is a typical double-strap arrangement.

In any design, it is necessary to insulate all the bolts from either of the two metal sheets with plastic sleeves and washers. It is sometimes desirable to use one flat sheet rather than individual plastic washers to avoid the possibility of one washer being left out. This would result in grounding the whole system. In this type of joint, the bending moment and consequent sheer stresses must be taken into account in transmitting a load from one metal to another.

▶ **Final Joint Designs**—As a result of the favorable laboratory evidence on material properties and characteristics of glass-reinforced laminates, the N. Y. Naval Shipyard Material Lab. prepared instructions for the design of two types of connections.[8] The insulated joints are basically the metal-to-metal and metal-to-plastic connections shown in Fig. 1, 2.

▶ **Condenser Box**—As for applications, the literature cites an example of electrical isolation of a cast-iron water box of a condenser from its nonferrous tube sheet assembly. This was to prevent graphitization of the cast iron member.[9] (Graphitization of grey cast iron is the phenomenon of having the metallic iron con-

Flange Connection Uses Plastic Insulators **Fig. 4**



stituent converted to corrosion products, leaving intact the spongy, low-strength graphite.) By electrically isolating this bimetallic couple and providing localized cathodic protection to the condenser head with zinc anodes, the condenser could operate trouble-free for years.

There are many cases aboard ship where it is desirable to separate dissimilar metal piping connected into a common header. Electrical isolation with plastics is recommended provided the fluid carried does not exceed temperatures above 160 F.

▶ **Insulated Coupling**—A striking example of an unusual isolated structural joint involved separation of the flange coupling on a propeller shaft.

Insulation of a bronze propeller from the stern area of a vessel was made to avoid the severe corrosion usually present in such areas.

An insulated coupling was installed on one of the outboard propeller flanges of a Navy patrol craft, the other propeller shaft remained uninsulated. This was done under the technical guidance of personnel of the N. Y. Naval Material Laboratory. The trial installation was to provide information on the service performance of the materials as well as the effectiveness of insulation on reducing stern hull corrosion. Zinc sacrificial anodes and rubber shaft coverings were installed as usual.

Two small test areas were sandblasted directly over each propeller to observe corrosive effects. A drawing of the insulated flange coupling is shown in Fig. 4.

The insulating ferrules for the bolts were fabricated using glass cloth and a general purpose, rigid-polyester resin having 2% benzoyl peroxide catalyst and 1% cobalt accelerator. The ferrules were cut from 20-in. length of tubing formed on steel mandrels, cured 1 hr. at 125 C., machined to the required outside diameter and then slipped off the mandrel ready for assembly.

A coating of catalyzed polyester resin was applied to the spacer, ferrules and washers.

A snug fit was made between the ferrules and the bolts, and the ferrules and the flange holes. The bolt was reduced in diameter to allow for mating with an insulating ferrule. Plastic surfaces were coated with the activated resin prior to assembly and torque applied periodically for 1 hr. after assembly to allow for creep in the separator and washers.

Electrical resistance measurements showed that insulation had been achieved. Resistance readings of 40 megohms were recorded across the insulated flange and 0 ohms across the other.

An inspection in drydock was recently made after a period of about 19 mo. of service.[10] Poorly adhering rubber shaft coverings were completely removed and the shaft examined. The insulated shaft from the flange back to the propeller was severely pitted and corroded. All other areas, including the noninsulated shaft, and the sandblasted areas were in good condition. The plastic insulater was found to be in excellent condition with no evidence of delamination, softening, distortion or pitting.

Because of the relative proximity of both propellers and zincs to the test areas, there was, naturally, interference between the insulated and uninsulated shafts. This was further complicated by the fact that the rubber coatings failed, permitting galvanic current flow between the propeller of the insulated shaft and the area adjacent to this propeller. Although this test could give no conclusions as to the effectiveness of the insulator in reducing electrolytic corrosion of the hull, it nevertheless indicated the durability under service of the plastic materials involved.

Electrical isolation of propeller shafts is not normally recommended for shipboard application unless provision is made for special propeller and hull cathodic protection systems.

Note: The opinions expressed in this article are those of the authors, and do not necessarily reflect the official views of the Navy Department.

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BRIEFS

on some recent developments in sodium chlorate... an easy way to get benzyl groups... what to look for in muriatic acid specs

Keeping up with the sodium chlorate demand

There has been such a surge of interest in sodium chlorate during the past few years that we have had the happy obligation of expanding our facilities three times.

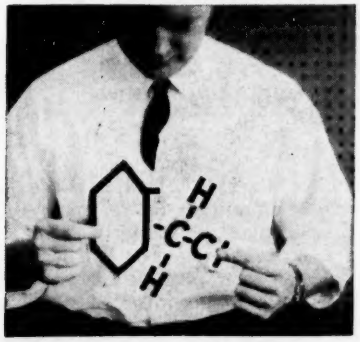
The most recent addition has been onstream at our Columbus, Mississippi plant since February of this year.

This will more than double the capacity this plant started with in 1954. Of course, in addition we also have large production facilities at our Niagara Falls location.

Much of this new tonnage is going into chlorine dioxide generation. As you probably know, the pulp and paper people are mostly responsible for this, but there is growing interest in other areas also.

New drum empties faster. Recently we introduced this new drum style on our sodium chlorate. A single lever seals and reseals the drum with a metal band. The full head area is opened for use. The old-style drum had a smaller opening and required the manipulation of four lugs for sealing. The new drum comes in 100 and 400-lb. net weights.

Data for your files on our sodium chlorate are offered in the coupon.



Handy way to get benzyl groups

If you want to tag benzyl groups onto some compound you're working with, we offer for your inspection Hooker benzyl chloride.

Here's a compound that's been around some time, so we have no trouble making it to specs in short time in any quantity.

The benzyl group of the compound reacts readily and can be easily led to fit into your own formulation.

The benzyl chloride we make is a clear liquid, colorless or light yellow to the eye. It has a characteristic pungent odor. It's insoluble in water but dissolves readily in alcohol and ether.

If you'd like a look at our specifications and typical data, we ask only that you fill out the coupon and send it to us.

We have a very similar story to tell on benzoyl groups as we make benzoyl chloride, too. So we also offer data on this chemical in the coupon.

What to look for in muriatic acid specs

This white gummy substance is an insoluble precipitate which can form in certain reactions with muriatic acid that contains too much sulfate.

Iron, arsenic, and free chlorine can also give a process indigestion when their level in muriatic acid is too high.

So it pays to consider these carefully when you examine any muriatic's specs.

Take Hooker White Grade muriatic, for example. Iron: a mere 0.0001% at the most. Sulfates: less than 0.003%. Free chlorine: none. Arsenic: none.

This Hooker White Grade is probably the purest muriatic you can buy anywhere in volume.

Very often your process can stand a little higher level of these impurities.

Hooker Commercial Grade offers these maximum specs: Iron: a low 0.0005%. Sulfates: 0.003%. Free chlorine: a slight trace. Arsenic: none.

Both grades are delivered in rubber-lined tank cars. Both are available in three strengths: 18°, 20°, and 22° Baumé.

For more complete technical data, check the coupon. And, if you'd like samples of either grade, just write us on your business letterhead to speed delivery.

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☐ Sodium Chlorate ☐ Benzoyl Chloride
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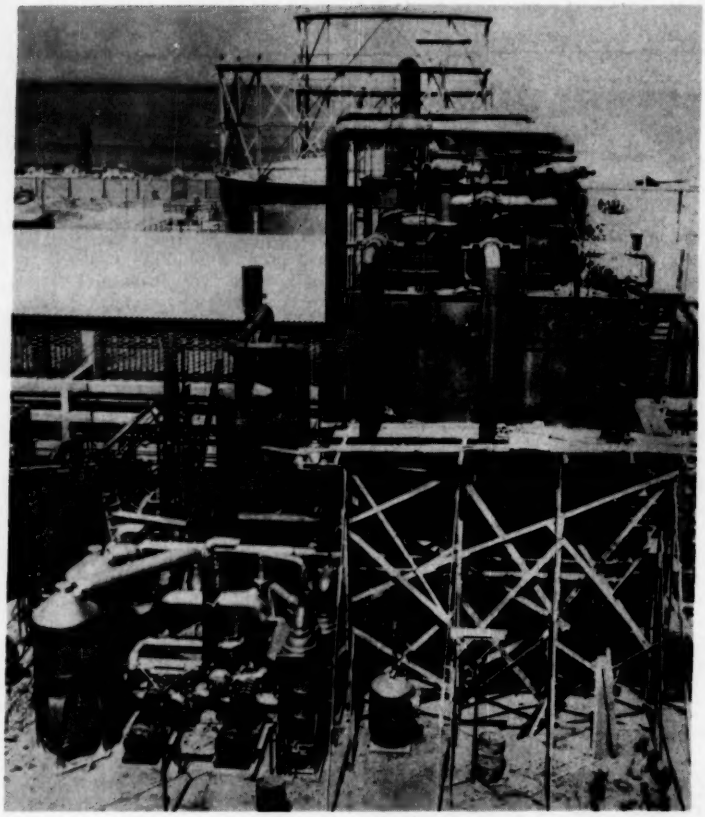
HOOKER CHEMICALS PLASTICS

FIRMS IN THE NEWS

J. A. KING

NEW FACILITIES



Towers to Separate Nitrogen for Ammonia Synthesis

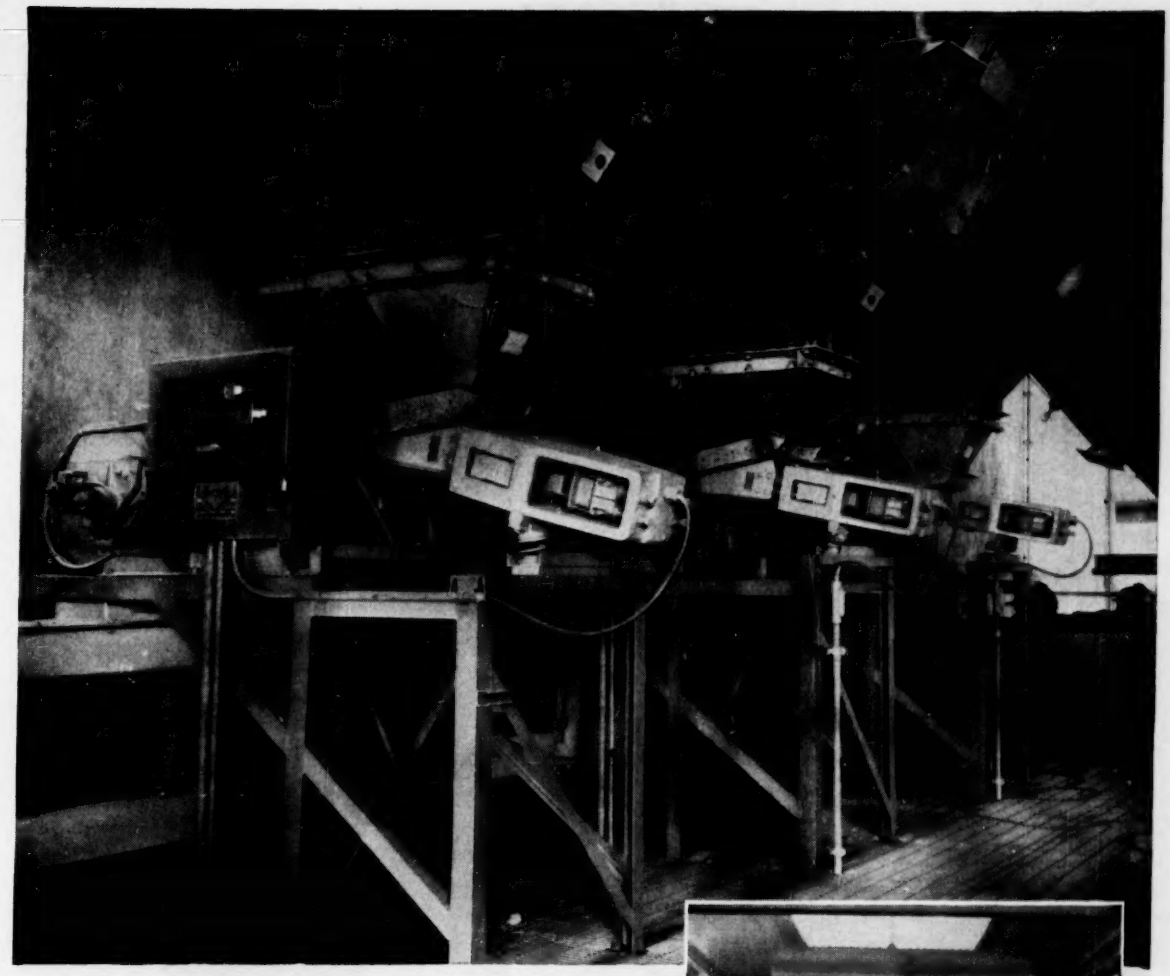
Montecatini is designing and building a $10-million fertilizer and chemicals plant, to be operated by Fertilizante Sinteticos S. A. at Callao, Peru. Plant to use the Fauser-Montecatini process will produce ammonium sulfate and nitrate fertilizers, ammonia, nitric acid and ammonium nitrate. Air fractionation towers for nitrogen separation are already constructed.

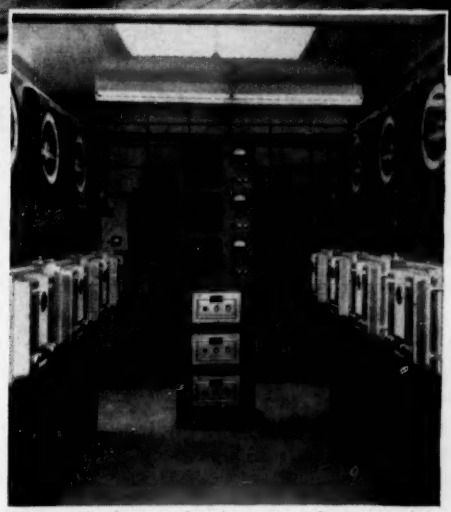
Monsanto Chemical Co. has put on stream its 10,000-ton/yr. polyethylene plant at Fawley, Southampton, England. Plant now produces low-density polyethylene, but will shift to high-density product soon.

Union Carbide Plastics Co.'s new 15-million lb./yr. epoxy-resin plant at Marietta, Ohio has just gone on stream. Epoxy resins will be marketed as coatings, reinforced plastic, laminating and adhesive material.

Beaunit Mills, Inc. is completing construction of a 10-million lb./yr. "Vycron," polyester fiber, plant. New plant will also produce polyester tow for direct yarn spinning.

Pennsalt Chemicals Corp. reveals plans to construct a $10-million caustic-chlorine





Jeffrey WAYTROLS® automatically proportion and feed raw materials

In this new cement plant, an automatic system incorporating Jeffrey WAYTROLS proportions and feeds raw materials. This permits mill operators to vary the rate at which the blended product is fed through process to suit requirements.

Jeffrey WAYTROLS can be used in many processes . . . can contribute to your plant efficiency. Where slurries or slimes are involved, WAYTROLS can provide accurate mix and fast low-cost processing. If just solid content is important, instruments can measure it and ignore water content.

For information on how Jeffrey processing equipment can help you, write The Jeffrey Manufacturing Company, 909 North Fourth Street, Columbus 16, Ohio.

These units (upper photo) are part of a group of 10 WAYTROLS in a new cement plant. Automatic controls (below) regulate raw feed ratios and control proportioning of materials.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT...TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

It's the Nash!

The ability of Nash Compressors to maintain original performance over long periods is no accident. Nash Compressors have but a single moving element, the Nash Rotor. This rotor is precision balanced for long bearing life, and it revolves in the pump casing without metallic contact. Internal lubrication, frequent cause of gas contamination, is not employed in a Nash. Yet, these simple pumps maintain 75 lbs. pressure in a single stage, and afford capacities to 6 million cu. ft. per day in a single compact structure.

Nash Compressors have no valves, gears, pistons, sliding vanes or other enemies of long life. Compression is secured by an entirely different principle of operation, which offers important advantages often the answer to gas handling problems difficult with ordinary equipment.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. Because there are no internal wearing parts, maintenance is low. Service is assured by a nation-wide network of Engineering Service offices. Write for bulletins now.

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature Automatically maintained.

Slugs of liquid entering pump will do no harm.

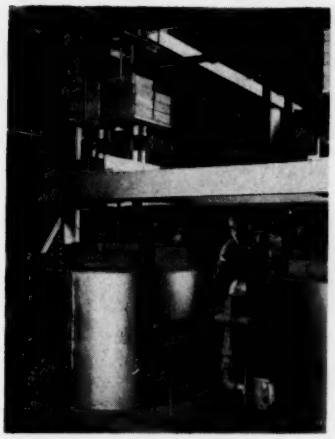
75 pounds in a single stage.

NASH ENGINEERING COMPANY

312 WILSON, SO. NORWALK, CONN.

plant in the Crofton Area of Vancouver, B. C.

Avison Corp., jointly owned by American Viscose and Sun Oil, announces plans for the construction of a 10-million lb./yr. polypropylene film plant at New Castle, Del. New plant is scheduled for completion by fall, 1959.



Harbison-Walker Refractories Co. opened its new $2-million Garber Research Center near Pittsburgh, Pa. Shown above are the new furnaces, used for load testing refractories at elevated temperatures.

National Cylinder Gas Co. div. of Chemetron Corp., began operation of its new transfilling depot at Odessa, Tex., is constructing similar plants at Saginaw, Mich. and Buffalo, N. Y.

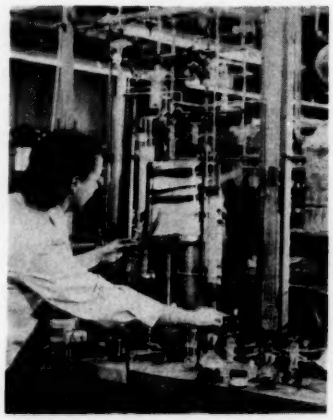
Reichhold Chemicals is building a new maleic anhydride plant. Badger Manufacturing Co. is engineering and constructing the plant.

Procter & Gamble has begun moving into the Winton Hill Technical Center, its new-product research and development activities. Research at Winton Hill will aim at development of new soaps, detergents and other consumer products.

Idaho Potato Starch Co. is constructing a starch processing

FIRMS . . .

plant to handle 300 tons/day of potato feed. New plant will be operated by Rio Grande Starch Co., div. of the Idaho company.



Engelhardt Industries, world's largest refiner of precious metals, opened its new $1-million research and development laboratory in Newark, N. J. High-vacuum apparatus shown above measures catalyst's surface area.

Victor Chemical will begin construction of a phosphoric acid plant in Chicago, Ill. New plant, to be completed early in 1960, will meet next year's demand for liquid plant foods, will be at the focal point of U. S. trucking, railroading and shipping activities.

U. S. Rubber has licensed its major competitors and other companies to vulcanize butyl rubber by its new process, which makes possible savings and improved rubber products.

International Minerals & Chem. Corp. announces realignment of its principal product divisions. Phosphate Minerals, Phosphate Chemicals opera-

tions and Potash Div. were joined together.

Dixon Chemical & Research, Inc. has joined with American Sulphur & Refining Co. to form Dixon-Western Chemicals, Inc. Newly formed company will build a 500-ton/day sulfuric acid plant at American Sulphur's Sulphurdale, Utah, property.

Armour and Co. has purchased a nitrogen plant from Mississippi River Fuel Corp. near Festus, Mo. Additional nitrogen capacity will be used to produce ammonia and nitric acid.

Atomics International has made an agreement with English Electric Co., Ltd., to collaborate in the development of organic-cooled nuclear reactors.

OVERSEAS BRIEFS

Standard Vacuum Oil Co. has awarded Fluor Corp. a $28-million contract for the construction of a petroleum chemicals plant at Altona, near Melbourne, Australia. Vacuum Oil Co. Pty., Ltd., a subsidiary of Standard Vacuum, will own and operate the new plant. Output will include 20,000 tons/yr. of ethylene and butadiene.

Esso, A. G. announces plans for the expansion of its tanker fleet to 550,000 tons. In the past seven months, Esso expanded its fleet to 250,000 tons, and completed construction of a $56-million refinery at Cologne, France.

Hewitt Robins, Inc. announced establishment of a subsidiary in Italy to increase services to European users of conveyor machinery, belting and vibrating screens. This is Hewitt-Robins' sixth foreign subsidiary.

CALENDAR

Gordon Research Conference: Radiation Chemistry, New Hampton School.
July 27-31 New Hampton, N. H.

Gordon Research Conference: Organic Coatings, Colby Junior College.
July 27-31 New London, N. H.

National Soybean Processors Assn.-American Soybean Assn., joint annual meeting, Sheraton-Jefferson Hotel.
Aug. 10-12 St. Louis, Mo.

American Pharmaceutical Assn., annual meeting, Netherland-Hilton Hotel.
Aug. 16-21 Cincinnati, Ohio

Gordon Research Conference: Chemistry and Physics of Metals, Kimball Union Academy.
Aug. 17-21 Meriden, N. H.

Technical Assn. of the Pulp and Paper Industry, 10th Testing Conference, Multnomah Hotel.
Aug. 18-21 Portland, Ore.

International Union of Pure an Applied Chemistry, symposium: Chemical Thermodynamics.
Aug. 20-25 Wattens, Austria

American Rocket Society, symposium: Gas Dynamics. Northwestern University.
Aug. 24-26 Evanston, Ill.

Gordon Research Conference: Instrumentation, Colby Junior College.
Aug. 24-28 New London, N. H.

Combustion Institute, 8th International Symposium on Combustion, California Institute of Technology.
Aug. 29-Sept. 2 Pasadena, Calif.

Chemical Institute of Canada, Physical Chemistry Div. meeting, McMaster University.
Aug. 30-Sept. 1 Hamilton, Ont.

International Union of Pure and Applied Chemistry, symposium: Thermodynamics and Thermochemistry.
Aug. 30-Sept. 6 Munich, Germany

American Society of Mechanical Engineers, International Air-Pollution Congress, Statler-Hilton Hotel.
Sept. 10-11 New York, N. Y.

Armed Forces Chemical Assn., annual meeting, Statler Hotel.
Sept. 10-11 New York, N. Y.

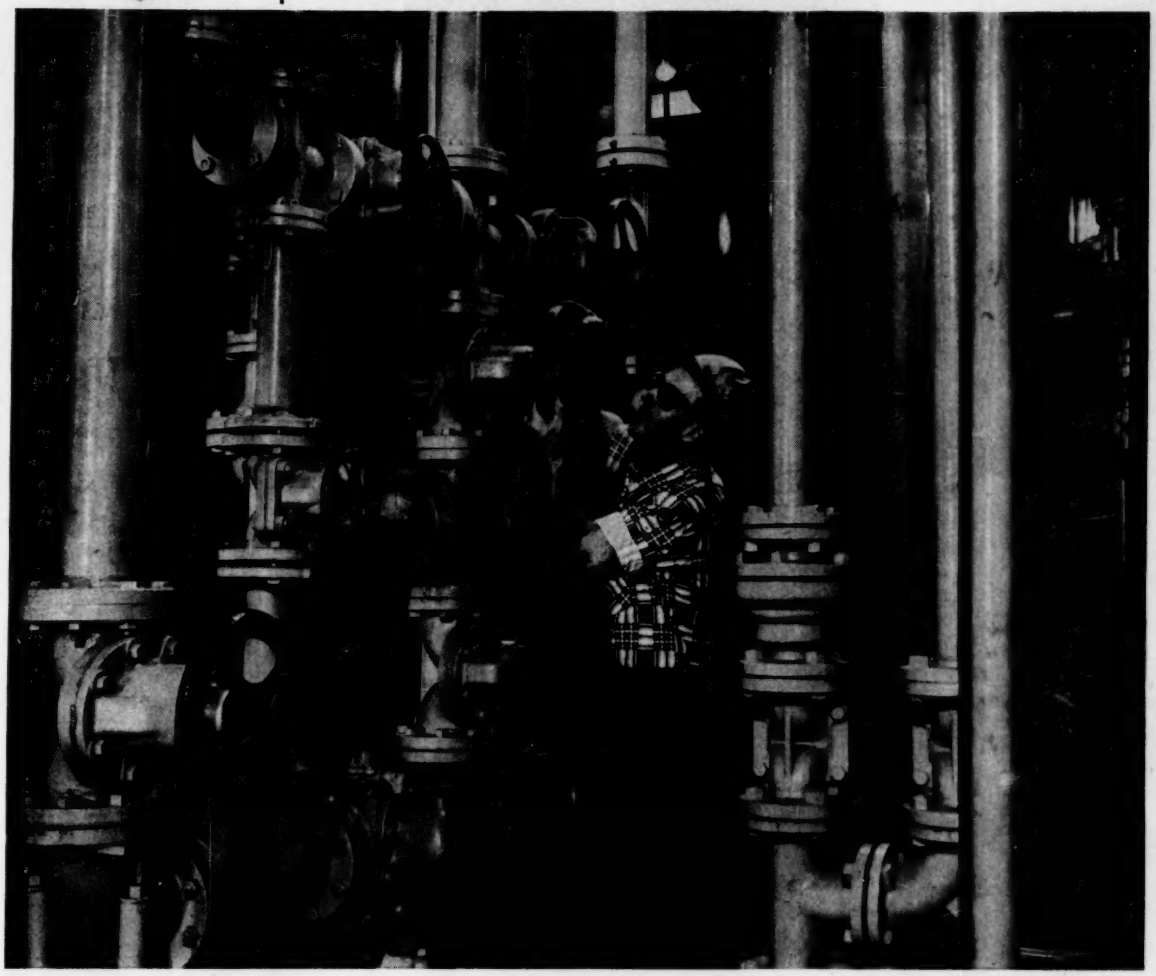
American Chemical Society, national meeting.
Sept. 13-18 Atlantic City, N. J.

National Industrial Conference Board, 7th annual Marketing Conference, Waldorf-Astoria Hotel.
Sept. 16-18 New York, N. Y.

Canadian Agricultural Chemicals Assn., annual meeting, Chateau Frontenac.
Sept. 20-23 Quebec City, Que.

Chemical Market Research Assn., conference: Textile Fibers.
Sept. 20-22 Williamsburg, Va.

DOW | **SARAN LINED PIPE**



5 miles of pipe, 12 years of service

Saran Lined Pipe keeps process acids flowing!

When five miles of process piping must carry an unfailing flow of highly corrosive acids, thorium salt solutions and slurries . . . when frequent flow changes require quick, on-the-spot pipeline modifications . . . that's when the extreme corrosion resistance and easy workability of Saran Lined Pipe make this process pipeline a process lifeline.

Above is one section of the approximately five miles of Saran Lined Pipe which carries process chemicals in thorium recovery operations at the American Potash & Chemical Corporation's Lindsay Chemical Division plant, West Chicago, Illinois. In this process, Saran Lined Pipe is required to carry highly corrosive materials: sulphuric acid slurries for ore leaching; reacted thorium sulphate solutions and waste slurries; concentrated hydrochloric acid, hydrofluoric acid slurries. The pipe network has been in constant use since 1947, and *there's never been a major process shutdown because of pipeline failure!*

Equally as important to Lindsay as corrosion resistance are the workability and strength of Saran Lined Pipe. The nature of the process requires frequent flow changes, meaning frequent changes in piping. Necessary pipeline modifications are done quickly and easily by plant personnel, cutting process downtime to a matter of hours. And high physical strength of the pipe minimizes the need for extensive pipe supports!

Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200°F. They can be cut, fitted and modified easily in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Ave., Ferndale, Michigan, Dept. 2283AK7-27.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

NEW EQUIPMENT . . .

(*Continued from p.* 90)

The equipment can be interpreted as the "logical controlling element" in a computer control loop. In this sense, applications include: maximizing dollar gain across a separation column; controlling solvent flow and heat for a maximum dollar output of products; and minimizing fuel costs in a boiler installation.

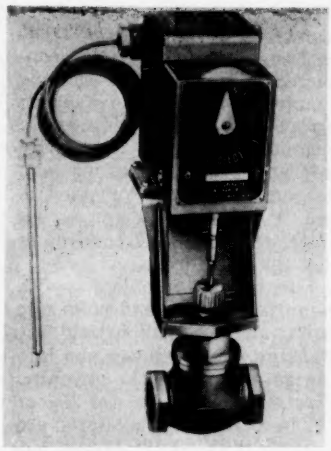
Outside the field of computer control, typical applications include holding a maximum or minimum conductivity or viscosity, and stabilizing both binary and multiple-product separation columns. Output is a modulated time signal with up to 100 w. of power.—**Quarie Controllers, Canton, Mass. 90D**

Speed Reducers

Install quickly, easily in limited space.

A new series of shaft-mounted speed reducers comes with capacities from 1 to 40 hp. for single-reduction gearing; double-reduction units range from 1 to 30 hp. Speeds with single gearing are 90 to 420 rpm.; for double reduction, they are 10 to 160 rpm.

All reducers use standard V-belts and pulleys, and are equipped with a torque arm that permits infinite belt adjustment. The units are designed for quick, easy installation, and require a minimum amount of mounting space. — **Lima Electric Motor Co., Lima, Ohio. 170A**

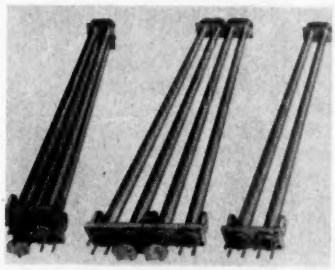


Temperature Regulator

Compact device provides proportional control.

Barber-Colman's new temperature regulator for proportional control of water, gas or low-pressure steam is designed for all applications requiring a self-contained valve assembly. Motor-operated, the regulator uses a simple two-wire connection to any 115-v. power supply.

Sizes for screw-type globe valves range from ¼ to 4 in.; with a flanged pattern, sizes vary from 2½ to 4 in. Scale range is 10 to 90 F. standard; maximum bulb temperature is 230 F. — **Barber-Colman Co., Rockford, Ill.** 171A



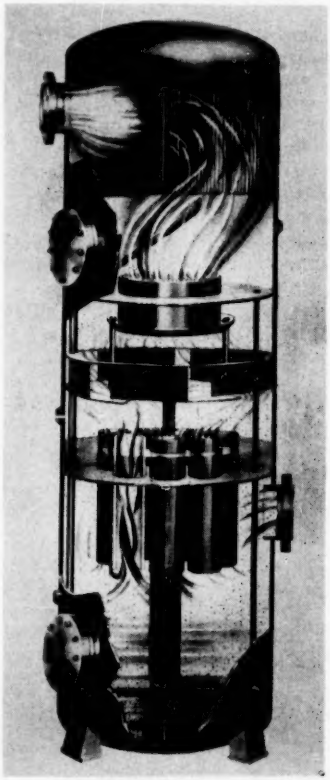
Modular Exchanger

Impervious graphite pipe sections; flexible system.

For highly flexible heat transfer capacity, Falls Industries' new exchanger system couples modular design with the corrosion resistance of impervious graphite. Basic com-

ponents for the countercurrent exchangers consist of two connected, concentric pipe sections mounted in heavy steel stacking plates. All flange openings are located at one end. The entire internal graphite section can be removed from the opposite end by releasing an access plate. Special interconnectors join the basic units.

Furnished complete with mounting fittings and bolts, the units are self-supporting for stacking. Corrosives come into contact only with the graphite. Pipe sizes available are 2⅛ or 2¾ in. O.D.; lengths offered are 6, 9 and 12 ft.—**Falls Industries, Inc., Solon, Ohio.** 171B



Gas Cleaner

Handles large volumes at high efficiencies.

New Type M-P gas cleaners will remove 80% of submicron particles, and practically 100% of particles greater than 2 to 3 microns. Capacities can vary

up to 18-million scfh. of gas at 1,000 psi., and for any design pressure.

Operating improvements over earlier models are attributed to internal changes that assure more and better contact of the gas with the scrubbing medium (four phases); additional and improved separation of the liquid from the gas (six phases); and internal control of the amount of scrubbing medium in circulation in proportion to gas flow.—**Buflovak Equipment Div., Blaw-Knox, Buffalo, N. Y.** 172A

BRIEFS

Battery charger line now includes a new group of completely automatic silicon rectifier-type models. The 30 new sizes come with a choice of electrical ratings for use with 6-, 9-, 12-, 15-, 16- and 18-cell batteries. Ratings range from 250 to 1,000 amp.-hr.—**Exide Industrial Div., Philadelphia, Pa.** 173A

New valve features a tapered nonturning plug disk; stem pinned to disk; handwheel attached to yoke sleeve; reduced seat and fine stem threads for accurate flow control. The 1-in. unit has a working pressure of approximately 1,500 psi.—**Crane Co., Chicago, Ill.** 173B

Pipe welding machine welds aluminum pipe faster, better and less expensively than ever, according to the manufacturer. The unit produces sound welds with full penetration, without the use of backup rings. Completion time for a pass on 4-in. pipe is 11 sec. The welder can process products having outside diameters of from 4 to 11 in. — **Aluminum Co. of America, Pittsburgh, Pa.** 173C

Nondestructive test instrument uses eddy currents to measure and sort nonmagnetic metals. The meter can also determine hardness, alloy and heat-treat condition; check tensile strength of aluminum; etc. Powered by flashlight batteries, the instrument has

an accuracy better than ±3% of scale reading.—**Magnaflux Corp., Chicago, Ill.** 173D

Pump line has been expanded to include two new models. One is a 500-hp., double-suction centrifugal pump capable of delivering 12,000 gpm. to a 150-ft. head. The second is a 28.5-hp. reciprocating model, which develops a maximum working pressure of 600 psi. and has a capacity of 126 gpm.—**Wilson-Snyder Works, Braddock, Pa.** 174A

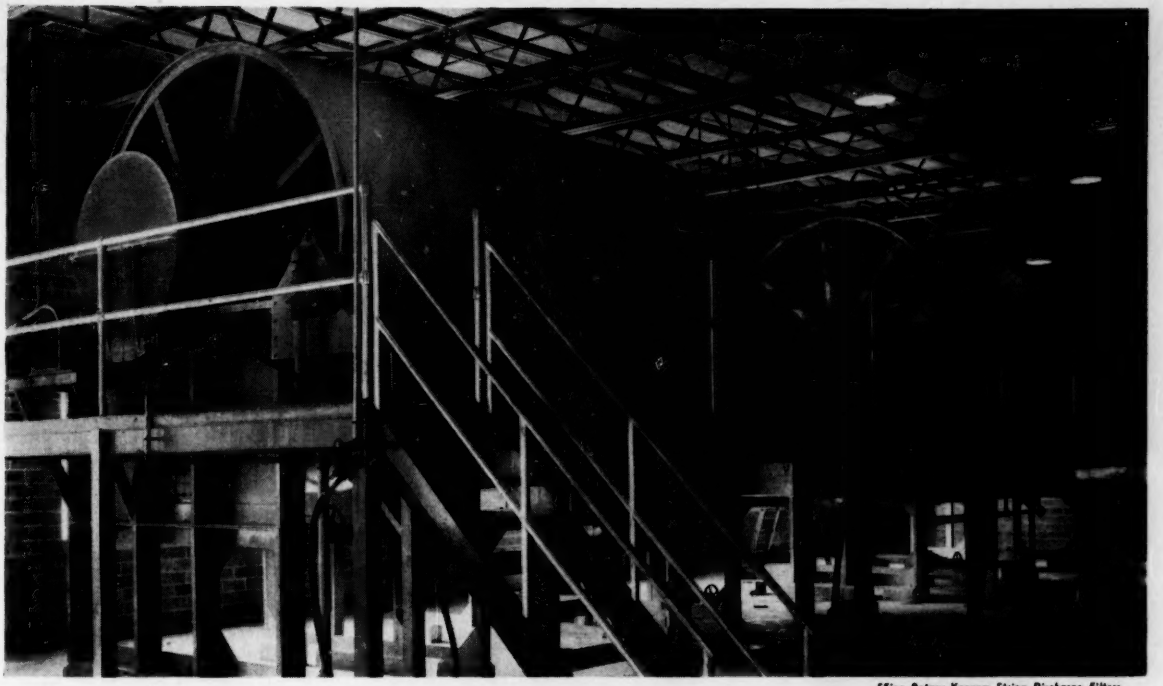
Extruded plastic pipe with 12-in. dia., Schedule 40 and 80, has been added to the manufacturer's PVC line. Fabricated plastic fittings are available for the new size. Standard stock length is 20 ft.; longer lengths can be supplied.—**Joseph T. Ryerson & Son, Inc., Chicago, Ill.** 174B

Screw-type coupling enables repeated dismantling and refitting of polyethylene or PVC piping systems. Major components of the coupling are available in plastic. Connections are vibration-proof, and can withstand high strain.—**Jakob Kummli, Kussnacht-Zurich, Switzerland.** 174C

Equipment Cost Indexes . . .

	Sept. 1958	Dec. 1958
Industry		
Avg. of all	230.9	223.7
Process Industries		
Cement mfg.	223.3	223.7
Chemical	232.3	232.7
Clay products	217.0	217.4
Glass mfg.	219.3	219.7
Paint mfg.	222.8	223.1
Paper mfg.	223.8	224.2
Petroleum ind.	227.5	227.8
Rubber ind.	230.3	230.6
Process ind. avg.	228.6	228.8
Related Industries		
Elec. power equip.	236.0	236.4
Mining, milling	233.7	234.1
Refrigerating	260.3	260.6
Steam power	218.1	218.4

Compiled quarterly by Marshall and Stevens, Inc., of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124—6 for method of obtaining index numbers; Feb. 23, 1959, pp. 149-50 for annual averages since 1913.



FEinc Rotary Vacuum String Discharge Filters at The Hubinger Company, Keokuk, Iowa.

FOR THE HUBINGER COMPANY . . .

STRING DISCHARGE FILTERS *solved the problem*

These FEinc rotary vacuum filters were recently custom built to specifications for The Hubinger Company, Keokuk, Iowa. The job they're doing is a tough one . . . filtering gluten derived from the wet milling of corn.

The string discharge design was selected as the only workable method for cleanly removing the thin, high-protein gluten cake which causes scraper filters to bog down. Each unit has over 500 square feet of filter area.

LOW MOISTURE CAKE CONTENT

Operating continuously, these string discharge filters eliminate blow-back and produce a cake of low moisture content. Stainless steel construction helps maintain product purity according to standards established in over 75 years of starch production.

The FEinc filters in this installation are examples of how custom-made units provide solutions to many difficult continuous filtration problems in the chemical processing industry.

For help with your problem, see our insert in Chemical Engineering Catalog or write today, Dept. CEF-759, for free bulletins and technical advice. Simply state your basic requirements.

For a Bigger Yield **FE INC®**

FILTRATION ENGINEERS
AMERICAN MACHINE AND METALS, INC.
EAST MOLINE, ILLINOIS

STRING HORIZONTAL SCRAPER

CUSTOM DESIGNED CONTINUOUS FILTRATION

TECHNICAL

"... cuts a wide swath across ... ... diverse disciplines ..."

FINE PARTICLE MEASUREMENT. By Clyde Orr, Jr., and J. M. DallaValle. Macmillan Co., New York. 353 pages. $10.50.

Reviewed by F. C. Nachod, Sterling-Winthrop Research Institute, Rensselaer, N. Y.

There is perhaps no other endeavor that cuts a broad swath across such widely diverse disciplines as petroleum or paint chemistry on one hand and medical research on the other as the study of particle size.

The chemist concerned with problems of catalyst activity or with the hiding power of paints is just as interested in particle diameters as is his pharmaceutical or medicinal colleague who prepares, let us say, particulate suspensions of hormones. The present text covering the inherent mathematics and the techniques (microscopy, sieving, sedimentation, adsorption and surface area) will thus have a wide and appreciative audience.

The only shortcoming this reviewer notes is the omission of the electronic counting method (Coulter), one of the truly exciting novel approaches to this old problem. The book, however, even with this omission, will be of considerable value to the worker in the field.

BRIEFLY NOTED

DEVELOPMENT OF A HEAT-TREATED TITANIUM SHEET ALLOY. 92 *pp. By C. R. Lillie and D. W. Levinson, Armour Research Foundation, for Wright Air Develop-*

BOOKSHELF

J. B. BACON

ment Center, U. S. Air Force. Order PB 151279 *from Office of Technical Services, U. S. Dept. of Commerce, Washington* 25, *D. C.* $2.25. Describes program leading to development of a beryllium-containing titanium alloy which provided 160,000 psi. yield strength for 0.2% offset at room temperature.

GUIDE TO THE LITERATURE OF PETROLEUM; APPENDIX TO THE GUIDE TO THE LITERATURE TO PETROLEUM. 43 *pp. and* 39 *pp. Science Information Associates, P. O. Box* 2284, *Houston* 1, *Tex.* $1.75 *and* $1.25. Gives reference problems and procedures, lists of reference works and names of trade and technical associations, with appendix if desired, relating to petroleum literature.

MODERN PEARLITIC MALLEABLE CASTINGS HANDBOOK. 76 *pp. Malleable Research and Development Foundation, Granville* 1, *Ohio. Free to anyone responsible for materials specification or selection.* Offers introduction to pearlitic malleable, gives charts containing information necessary to translate design needs into final specifications for pearlitic malleable.

REPORT OF THE JOINT PROGRAM OF STUDIES ON THE DECONTAMINATION OF RADIOACTIVE WATERS. (ORNL-2557) 62 *pp. Official requests for copies will be honored by Public Health Service and Atomic Energy Commission. Also available from Office of Technical Services, U. S. Department of Commerce, Washington* 25, *D. C.* $1. Studies effectiveness of water treatment processes in the removal of radioactive waste materials.

MORE NEW BOOKS

FLUIDIZATION. By Max Leva. McGraw-Hill. $11.50.

RUSSIAN FOR THE SCIENTIST. By John Turkevich and Ludmilla Turkevich. Van Nostrand. $5.95.

TRANSLATION FROM GERMAN FOR CHEMISTS. By H. H. Neville and W. E. Yuill. Interscience. $2.50.

LETTERS:

JUST BETWEEN US...

Dear Readers:

What possible connection is there between rare earths and an early morning rendezvous in a dimly lit bar? Normally, none. But in the case of our cluster of rare earth stories in this issue such a rendezvous played a vital part that illustrates how *CE* editors track down information from primary sources.

When Assistant Editor Frances Arne asked Midwest Editor Pete Forbath to get a description of Lindsay's rare earth process for her story, "Which Process to Unlock Rare Earths From Raw Ore?" (p. 62) little did she know that Pete's bird-dogging would lead to a dawn meeting in a Chicago bar. But let Pete tell it:

"In order to catch Lindsay's Howard Kremers, apparently a much-traveled man, I arranged to meet him at 7:30 a.m. at Midway Airport. At that hour, Midway is something of a madhouse. What's more, other than a standup and counter snack bar, no restaurants are open. Consequently, I took Dr. Kremers across the road to a dark, dingy, somewhat sinister bar for my interview.

"At that hour neither of us, of course, was interested in imbibing liquor. Instead, we conned the bartender into bringing us coffee and toast, which we consumed perched on stools up against the bar. Then we launched into a discussion of such merry things as rare earth halides and ion exchange.

"Our bartender was fascinated. He took great interest in the flowsheets and chemical formulas that Kremers sketched out for me and gladly kept our coffee cups filled. His underbreath comment: 'Man, a bartender meets everybody, but everybody.'"

Pete's interview with Dr.

PRO & CON

C. H. CHILTON

Kremers followed an earlier visit to Michigan Chemicals' rare earths plant—the first detailed tour of that facility by an editor. From Pete's exhaustive notes, Clem Labine fashioned our Process Flowsheet (p. 104).

In addition Clem talked with P. R. Kruesi, Heavy Minerals Co.'s general manager, to get the other half of Frances' story. And in checking other sources, Clem collected still more material which he wove into "Rare Earths Face 2 Challenges" (p. 65). We hope you like our collective efforts.

C. S. CRONAN
Chemical Engineering
Associate Editor

Pro: New Binding

Sir:

You are to be congratulated on your new tear-out pages in *Chemical Engineering*. Your system permits ready removal of pages for filing, yet leaves the remainder of the magazine intact. We appreciate the improvement.

MARK F. LITTEKEN
Monsanto Chemical Co.
St. Louis, Mo.

Sir:

I'm glad you finally took out the staples. The new system is far superior to perforations.

WILLIAM COPULSKY
W. R. Grace & Co.
New York, N. Y.

Sir:

Thank you for the improvement in *Chemical Engineering* with its flat opening, which makes reading much easier, and with its simple page removal, which permits selecting articles for files without engaging in a wrestling match.

W. F. JENSEN
Somerville, N. J.

▶ *Thanks to all our readers who expressed such an overwhelming opinion in favor of our new binding.*—ED.

READER SERVICE . . .

TECHNICAL

Contents of This Issue

Chemicals

Acrolein.....22 p. booklet aims at outlining the potential of acrolein and its derivatives. Includes sections on acrolein chemistry, physical properties, safe handling in the lab.
180A Shell Chemical Corp.

Antiozonants.....An effective laboratory procedure for screening organic compounds as potential antizonants has been developed. Additional information on request.
16-17e *American Cyanamid Co.

Anti-static Agent.....Catanac SN prevents the accumulation of static charge on a wide variety of substances including textiles, plastics, paper, etc. Information.
16-17a *American Cyanamid Co.

Benzoyl Chloride.....Data on this chemical is now available on request. The complete story on benzoyl groups is included with this data.
161c *Hooker Chemical Corp.

Benzyl Chloride.....has a characteristic pungent odor. It's insoluble in water but dissolves readily in alcohol & ether. Specifications & typical data offered.
161b *Hooker Chemical Corp.

Carbon Black.....12 p. bulletin covers company's general purpose furnace carbon, Statex G. How it fits into the family of rubber carbons, basic properties.
180B Columbian Carbon Co.

Caustic Potash.....New tech. Bul 15 contains properties & its solutions . . . data on unloading, handling, dissolving . . . conversion tables . . . vital facts, etc.
81a *Allied Chem., Solvay Process

Chemical.....BPL (beta-Propiolactone) can be useful within a wide range of applications. It is being evaluated for many other uses. Further information available.
73 *Celanene Corporation

* From advertisement, this issue

LITERATURE

E. M. FLYNN

Chemicals.....Butynediol reacts as a glycol & a disubstituted acetylene. A 44-pg. bulletin describes physical properties, storage, handling, chemical properties & uses.
85 *Gen. Aniline & Film, Antara Chem.

Copolymer, PVAc.....2 p. data sheet 4212 describes a new carboxylated polyvinyl acetate copolymer resin. Resin has higher degree of carboxylation standard PVAc Resins.
181A Shawinigan Resins Corp.

Esters.....48 p. booklet outlines the properties and application of 26 esters. Includes physical properties and sections on esters' use in solvents, use in specialties, data.
181B Union Carbide Chemicals Co.

Fiber, PVA.....5 p. bulletin gives physical properties of polyvinyl alcohol fiber, fabric characteristics, mill and wet processing and dyeing. Two tables on end use value.
181C Air Reduction Chemical Co.

Industrial Gases.....30 p. booklet on oxygen, nitrogen, argon, helium, acetylele, hydrogen, carbon dioxide and rare gases like xenon, neon, krypton, atmospluric helium.
181D Air Reduction Co.

Insecticides.....Malathion-base insecticides are used to protect fruits, ornamentals, livestock, etc. Its low toxicity to man & animals make one of the safest insecticides.
16-17d *American Cyanamid Co.

Lubricant, Fiber.....Technical Bulletin 414 describes a new water soluble, anti-static fiber lubricant for all natural and synthetic fibers. Data on static control, scourability.
181E Emery Industries, Inc.

Muriatic Acid.....White Grade and Commercial Grade are delivered in rubber lined tank cars. Both are available in three strengths: 18, 20 & 22 degrees Baume. Data.
161d *Hooker Chemical Corp.

Polyester Pre-Mix Molding Compound.....Laminac offers high impact strength, excellent flame & heat resistance, low moisture absorption, electrical properties, data.
16-17b *American Cyanamid Co.

* From advertisement, this issue

Want to build up your files and keep them up-to-date? You can get any publication in this comprehensive guide — free — just for the asking.

It's easy — simple circle item's number on the Reader Service Postcard and mail. Replies will come directly from companies offering the literature.

LITERATURE . . .

Polyethylene Film.....Commercial polyethylene film standards now being circulated for approval by the Dept. of Commerce are previewed in 4 p. bulletin.
182A U. S. Industrial Chemicals Co.

Polyglycol.....Third edition of 24 p. bulletin, "choosing the Right Polyglycol" lists descriptive and use information for 40 polyglycols. Includes formulas, molecular, weight.
182B Dow Chemical Co.

Polystyrenes.....24 p. bulletin C-9-231 covers product performance of company's complete line of polystyrenes. Two section cover normal and modified polystyrenes.
182C Koppers Co.

Protective Coatings.....8 p. leaflet covers the applications and economics of spray-on, strip-off coatings. Stresses advantages in protecting sensitive finishes of metals.
182D Spraylat Corp.

Reagents.....200 p. catalog lists over 4,500 items including organic chemicals, laboratory reagents, spectroquality solvents & biological stains. Includes chemical formulas.
182E Matheson Coleman & Bell

Silicon Carbide.....4 p. bulletin on silicon carbide-bonded graphite lists the description, properties, erosion test results and fabricability of the new product.
182F Carborundum Co.

Sodium Chlorate.....now in new drum comes in 100 and 400-lb. net weights. Data for your files on sodium chlorate is available on request.
161a *Hooker Chemical Corp.

Urethanes.....30 p. booklet reprints ACS paper, "The Development of Cast Urethane Elastomers for Ultimate Properties," by K. A. Pigott et al. with charts and graphs.
182b Mobay Chemical Co.

Water Soluble Polymer.....Accostrength Resin 2386 is used for either stock addition or surface application to paper & paperboard. Additional information offered.
16-17c *American Cyanamid Co.

Construction Materials

Alloys.....Titled "PH55 Alloys," new booklet contains information on composition ranges, mechanical properties, corrosion resistance of series of stainless alloys.
182H Cooper Alloy Corp.

Alloys.....Full information on corrosion-resistant alloys, their properties, forms, the corrosives they will resist are all contained in a 104-page book.
155 *Haynes Stellite Co.

Aluminum.....for electrical systems or electrical equipment. Brochure "Reynolds Aluminum in the Electrical Industry" is now available on request.
8-9a *Reynolds Metals Co.

Any bulletin or catalog . . . yours for the asking

* From advertisement, this issue

Aluminum Conduit.....features less voltage drop, & corrosion resistance. Its clean, modern appearance complements modern architecture. New booklet offered.
39 *Aluminum Co. of America

Chemical Porcelain.....Y-Valves and Angle Valves available in Turfclad chemical porcelain. Also safety valves, flush valves, plug cocks, etc. Description & specification.
147 *Lapp Insulator Co., Inc.

Insulation.....Calsilite, one-layer insulation for soaking heat up to 1250 F. Lightweight & easy to cut & mitre. Absorbs moisture without disintegration. Details.
R189 *The Ruberoid Co.

Platinum-Group Metals.....provide greater strength, lower weight, higher electrical & thermal conductivity. Technical Data Bulletin PLA-5 gives information.
4 *Metals & Controls Corp.

Protective Coatings.....Four-page chart "Comparison of Maintenance Coating Systems" aids personnel concern with buying and specifying corrosion-resistant coatings.
183A Carboline Co.

Protective Coatings.....Kerpon for the shipment & storage of chemicals, acids, solvents, foods & other corrosive materials in steel pails & drums. Details.
R196 *Kerr Chemicals Inc.

Seals, Mechanical.....Chemiseal Mechanical Seals for all pump shafts from ⅞" to 2½". Special sizes also available. Complete details & Catalog AD-164.
185 *The Garlock Packing Co.

Synthetic Rubber.....Viton shows outstanding resistance to high temperatures (450 F. and up). It has low compression set, high modulus & good tensile strength. Booklet.
79 *E. I. du Pont de Nemours & Co.

Teflon.....A new ready-reference book illustrates & describes the broad range of packings, gaskets, sheets, tapes & other components made of Chempac Teflon. Brochure
77 *Johns-Manville

Electrical & Mechanical

Drives.....Air magnetic tube expander drives and also electric control tube expanders and related accessories are covered in descriptive literature.
181 *Elliott Co.

Drives.....40-150 hp. Super T VS available for immediate delivery. Delivery schedules of the complete lines, 1-350 hp. are now available on request.
209 *Reliance Electric & Engr. Co.

Explosion-Proof Lighting Fixtures..... Series AA-51 with exclusive new anti-vibration guard are covered in booklet. Includes illustrations, and outstanding features.
183B Appleton Electric Co.

Modular Storage Batteries.....Subject of Brochure I-1 is a new replaceable-cell, lead acid storage battery. Three cell types can satisfy most battery requirements.
183C Scranton Cellomatic

* From advertisement, this issue

LITERATURE . . .

Motors.....Open-type motors with Poxeal insulation. A durable case of epoxy-resin encloses the winding end turns and slot portions of the stator. Information.
149 *Allis Chalmers

Motors.....A complete line of a.c. and d.c. standard motors, special motors, gearmotors and adjustable-speed drives is the topic of Bulletin 2650. Eight pages.
184A Louis Allis Co.

Motors.....Type EP are available in ratings through 500 hp. Bul. MU-224 covers standard & explosion-proof totally-enclosed fan-cooled motors.
98 *Wagner Electric Corp.

Rectifiers.....such as germanium silicon, & selenium, as well as mercury arc rectifier units of the pumped or sealed type in open or enclosed construction. Details.
153 *Allis-Chalmers

Starters.....Air-break high voltage starters feature 3-way padlock protection. They are furnished with a control transformer. Details in Bul. 8130-F.
51 *The Electric Controller & Mfg. Co.

Turbines.....for you in sizes up to 6000 hp. In special cases higher outputs can be supplied. Information about multistage turbines in bulletin S-146.
96 *The Terry Steam Turbine Co

Handling & Packaging

Automatic Control Device.....Roto-Guard shaft motion indicator provides positive indication of drop in speed or stopping of machinery. Protects conveyors, etc. Bul RG-16.
T190 *The Bin-Dicator Co.

Bucket Elevators.....A complete line makes it easy to select the proper type bucket elevator & components best suited to your material & capacity requirement. Details.
37 *Link-Belt Co.

Chlorinator.....A booklet "The V-notch Story" will tell you about all the V-notch chlorinator features. Also information on both gravimetric & volumetric feeders.
195 *Wallace & Tiernan Inc.

Conveyors, Tubular.....move almost any flowable material wet or dry—through any plane or angle. Sealed pin chain design keeps abrasives out. Information.
BL187 *Hapman Conveyors, Inc.

Electric Weighing Systems.....New brochure covers electric weighing systems for tanks, bins, hoppers, etc. Contains specifications and examples of applications.
184B Gilmore Industries, Inc.

Flaring Pails.....offer greater strength & protection for liquid-roofing cements, paint & petroleum products, dry or powdered materials. Details available.
165 *Continental Can Co.

Materials Handling.....Dinosaur automatically picks-up, hauls, dumps, etc. Models for single or tandem axle chassis . . . 22,000 to 30,000 lb. gross loads. Brochure.
94 *Dempster Brothers

* From advertisement, this issue

LITERATURE . . .

Payloader.....Model H-25 has breakout force of 4,500 lbs., carrying capacity of 2,500 lbs., running radius of 72 inches. Additional data available.
48 *The Frank G. Hough Co.

Heating & Cooling

Boilers.....Package water tube boilers are available in oil and/or gas fired types in standard pressures of 175, 250 and 375 pounds per square inch gage. Literature.
133 *Henry Vogt Machine Co.

Cooling Towers.....Class 600 Cross-Flow cooling towers are covered in Bulletin CF-59. All longer-life factors are covered in complete detail.
47 *The Marley Company

Gas Dryers.....For drying gases at elevated pressures (1,000 to 6,000 psi), the manufacturer offers a new series of desiccant dryers. Units dry to dew points of —160 F.
185A C. M. Kemp Mfg. Co.

Heat Exchangers, Brazed Aluminum.....can handle as many as five fluids simultaneously. Units are available for either cross flow or counter flow operation. Info.
22-23 *The Trane Co.

Kilns, Rotary.....Kiln shells are fabricated of quality steel plate. Complete details contained in Bulletin No. 1115, now available on request immediately.
32 *Traylor Engineering & Mfg. Co.

Plate Heat Exchanger.....Its stainless steel plates have multiple benefits: corrosion resistance, easy cleaning, lack of maintenance problems, adaptability, etc. Facts.
18-19b *The De Laval Separator Co.

Refrigerators.....Four types of special cryogenic refrigerators are described in new folder. Equipment utilizes liquid nitrogen as the refrigerant. Design features.
185B Linde Co.

Steam Trap.....combined with fine screen strainer for all types of steam equipment. All the details are contained in the Steam Trap Book. •
162 *Yarnall-Waring Co.

Steam Traps.....A 48-pg. book tells how to correctly size, install & maintain steam traps for any pressure, temperature or any load. Also Catalog K for data.
42 *Armstrong Machine Works

Steam Traps.....The 3-part TD-50 Steam Trap has only one moving part—the hardened, polished stainless steel disc. Literature Kit 2A & bulletins available.
50 *Sarco Company, Inc.

Instruments & Controls

Controls, Temperature.....Details of the pneumatic, electric or self-contained gas control (recording, indicating or non-indicating) are available on request.
143 *The Partlow Corp.

* From advertisement, this issue

LITERATURE . . .

Gauges.....High pressure gauges used in Refineries & Chemical Plants throughout the world. Complete catalogue on large chamber reflex gauges & heated or cooled gauges.
L168 *Strahman Valves, Inc.

High-Pressure Gages.....Catalog contains specifications and photographs on the new Rochester high-pressure gage. Construction details. Available on request.
186A .Rochester Mfg. Co.

Instrumentation.....Consotrol includes control functions for all types of processing requirements—auto-selector . . . cascade, ratio systems, automatic batch control. Bul. 13-18.
20-21 *The Foxboro Co.

Level Gage.....An industrial nucleonic instrument for monitoring and controlling height of materials in containers and equipment is the subject of a new bulletin.
186B Nuclear Corp. of America

Leverage System.....Controls processing or materials handling by weight. Literature on its application to filling, batching & check-weighing operations is available.
174 *Thayer Scale Corp.

Pressure Transmitter.....The No. 4700 offers accurate, dependable pneumatic transmission of pressure or temperature. Bulletin contains complete details.
24-25 *Mason-Neilan

Recorder-Controller.....unit continuously & simultaneously records 4 variables on the same chart. Clear, easy-to-read records for continual analysis & control.
46 *Bailey Meter Co.

Viscometran.....Viscosity can be continuously process controlled with the Viscometran. Complete information on how it can provide "in process" measurement.
R187 *Brookfield Engineering Lab., Inc.

Pipe, Fittings, Valves

Expansion Joints.....are hydraulically formed. Welding techniques insure welds having the same thickness, strength & physical properties. Catalog 56.
141 *Zallea Brothers

Fittings.....Glassed ductile iron fittings exhibiting physical & chemical properties similar to Glasteel 59's. Offer excellent corrosion resistance. Details.
210 *Pfaudler Permutit Inc.

Pipe.....All-purpose rigid PVC in schedules 40, 80, & 120. ½ to 4". Threaded or socket-weld fittings. Valves ½ to 2". Bulletin CE-56.
167b *American Hard Rubber Co.

Pipe.....Saran Lined Pipe, fittings, valves & pumps are available for systems operating from vacuum to 300 psi, from below zero to 200 F. Information available.
169 *The Dow Chemical Co.

Pipe & Fittings.....Data on Fluoroflex-TS pipe & fittings for complete piping systems is offered. They are universally inert, corrosion-proof, non-contaminating, etc.
41 *Resistoflex Corp.

* From advertisement, this issue

ADAMS FACT FILE #3

INSTRUMENT AIR

Clean Dry Air Supply Will Reduce Production Down-Time . . . Instrument Maintenance . . .

Wet, dirty compressed air has no place in the process industries. In instrument air supply lines it can cause havoc. Whether it be motor air in a control circuit or supply air to the control panel, absolutely clean dry air is vital. Moisture elimination is the major consideration in providing suitable air for instrument and control systems.

Since most plant compressors in use today are oil lubricated, a finite amount of oil is present with the water vapor in the discharge. This carry-over condenses as an oil-water emulsion which often causes serious fouling of instrument components. To eliminate this oil-moisture condensate in the air lines, it is necessary to remove it before it reaches the distribution system. This is done by cooling the air before the receiver. It is advisable to cool well below the ambient conditions to provide the lowest possible humidity at the instrument panel or control units.

Two Stage System Design for Economy

The ideal method to achieve high quality air is a two-step operation.

1—An Adams Aftercooler . . . providing 2° F. cooling . . . and Cyclone Separator installed between the compressor and receiver to remove the bulk of moisture carry-over.

2 — A chemical dryer installed down stream to provide the polishing action necessary for the desired minimum humidity.

Thus, the bulk of water . . . 90% . . . is removed by the Aftercooler-Separator using plant water for cooling. A minimum moisture load is then left to be removed by more expensive methods. Under normal circumstances, all of the oil present in the compressor discharge will be removed in the Aftercooler-Separator. Fouling of the chemical unit is then virtually eliminated.

Poro-Stone Air Filter at Panel Provides Dirt-Free Control Air . . .

In spite of the efficiency of the Adams Aftercooler and Separator, there still will be some dust and dirt present in the instrument air system. That's why it is advisable to install an Adams Poro-Stone Air Filter in the line just before the control panel.

Separation by the Adams unit is in two stages — centrifugal and diffusion. Centrifugal force throws the foreign matter to the walls of the filter body where it is trapped in slots and drained. Remaining particulate matter is removed as the air passes through the pores of the Poro-Stone element.

This final protection for your instruments will minimize control system failures and process down-time. Instrument maintenance will be sharply reduced.

Literature Will Help Air System Design

For further information on how the complete line of Adams air equipment can help you provide a foolproof instrument air supply, write today for your copy of Bulletin No. 712 on Aftercoolers and Separators and Bulletin No. 117 on Poro-Stone Air Filters to the R. P. Adams Company, Inc., 207 East Park Drive, Buffalo 17, New York.

LITERATURE . . .

Pipe, Plastic.....Flexible poly pipe. ideal for water lines, drains, underground pipe or conduit. Sizes arrange from ½ to 2", long coils. Bulletin CE-57.
167c *American Hard Rubber Co.

Pipe, PVC.....performance data is available on corrosion resistance, allowable stress, temp., pressure, impact, vibration, etc. New 32-page illustrated catalog offered.
31 *A. M. Byers Co.

Pipe, Pyrex.....is rugged, chemically insert & it withstands extremes of thermal shock. Facts on application design, and installation in Bulletin PE-3.
177 *Corning Glass Works

Plastic Piping Systems.....Engineering Handbook 159 on designing is offered. Research & development available for your specific corrosion problems.
61a *Chemtrol

Pressure Plugs.....Pressure plugs that seat flush are discussed in a new bulletin. Tables and charts give complete specifications for a range of sizes from $\frac{1}{16}$ to 1¼ in.
189A Standard Pressed Steel

Steam Specialities.....Steam specialties—valves, thermostatic traps, float and thermostatic traps and line strainers—are discussed in composite Bulletin 203.
189B American Air Filter

Tube.....A complete line to meet your particular demands. Field Engineering Service for problems dealing with alloys, corrosion, design or fabrication. Catalog.
65A *Wolverine Tube, Calumet & Hecla

Tubing, Plastic.....Tygon tubing is flexible, light in weight, & available in continuous lengths. Bulletin T-97 gives complete technical data.
52 *U. S. Stoneware

Tubing, Stainless.....ranges from $\frac{3}{16}$" OD to 3½" OD with wall thickness from .013" to .375". New 32-page book of technical data, sizes, grades & suggested applications.
43 *Allegheny Ludlum Steel Corp.

Valves.....Circular AD-2080 gives complete descriptive & specification data on corrosion-resistant alloy valves. Includes application guide covering many corrosive fluids.
33-36 *Crane Co.

Valve.....Improved seating in "Craneloy 20" globes increases valve life. Complete specifications and recommended applications are now available.
109 *Crane Co.

Valves.....for vacuum service are available in sizes from ½" to 20" & in manual or remote operated models. Additional details on request.
44 De Zurik Corp.

Valve.....New 90 degree on-off Flo-Ball for 3,000 PSI is ideal for leakproof control of air, vacuum, steam, water, etc. New catalog describes complete line of valves.
67 *Hydromatics, Inc.

Valves, Control.....for erosive or non-erosive flows . . . or other process flow conditions. Available in a wide range of types & sizes. Catalog C800-1.
102 *Minneapolis-Honeywell

* From advertisement, this issue

Process Equipment

Centrifugal.....Low product moisture, high capacity & economical operation are functions of the Reineveld Centrifugal. Complete information in Bulletin 356.
B190 *Heyl & Patterson, Inc.

Centrifugal Separators.....gives continuous, high capacity concentration of solids regardless of the amount, or particle size, of the solids present in a liquid. Facts.
18-19a *The De Laval Separator Co.

Centrifugal Separators.....Booklet describes the design, operation and advantages of Merco centrifugal separators for five basic liquid-solid applications.
190A Dorr-Oliver Inc.

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179 *The Western States Machine Co.

Compact System.....is a package of integrated equipment; the new compacting mill, a roller mill & either a gyratory or vibrating screen. Details in Bul. 07B8836.
151 *Allis Chalmers

Continuous Dewatering Presses..... can can lined with or fabricated from stainless steel, bronze or other corrosion resistant materials. Catalog A.
TL207 *Davenport Machine & Foundry

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172b *Simon-Carter Co.

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188 *McGraw-Edison Co.

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145 *Western Precipitation Corp.

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139 *Nettico Corporation

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171 *Black, Sivalls & Bryson, Inc.

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18-19c *The De Laval Separator Co.

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180 *C. G. Sargent's Sons Corp.

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L189 *R. P. Adams Co., Inc.

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R168 *Sturtevant Mill Co.

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167a *American Hard Rubber Co.

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184 *Manton Gaulin Mfg. Co.

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BL207 *Nagle Pumps, Inc.

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108a *American Optical Co.

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204 *The Boardman Co.

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111 *Newport News Shipbuilding

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108c *American Optical Co.

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108b *American Optical Co.

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▶ **Coverage** — National Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

▶ **Rates**—$21.75 per inch for all ads except on a contract basis; contract rates on request. Ad advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

▶ **Closing date** — August 24th issue closes July 31st. Send all new ads to Chemical Engineering, Classified Adv. Division, P. O. Box 12, New York 36, N. Y.

COMPLETE BOILER HOGGER PLANT

Wickes Vertical W.T. Boiler, 337', 20,000#, 175 psi.—Mitts Merrill Hogger with complete Hogger storage, Preparation, conveying, & feed systems. Burners. Pumps. Cinder & Fly Ash Collectors. Thermix Stack, etc. Complete set-up including structural steel Bldg. Recent installation. Excellent Condition. Must Sell. Will sacrifice for immediate package deal. Dealer participation invited.

INDUSTRIAL ENGINEERING ASSOCIATES
P.O. Box 3122, Philadelphia 50, Pa.

PEBBLE MILL

Abbe' continuous pebble mill 42" dia. x 6' long, with Buhrstone lining and pebbles. Spiral feed, grate discharge.

FILTER

Oliver continuous disc type vacuum filter. 4 disks, 4' diameter (86 sq. ft.). Stainless steel fittings and accessories.

DRYER

Blaw Knox Double Drum (cast iron) dryer. Series 500, #505. Top spray feed, standard knives, stainless steel enclosure and accessories.

CHARLES LAURANCE, INC.
P.O. Box 689 Weehawken, N. J. UNion 4-1010

SUPER-D-HYDRATOR

Sharples C-20, type 316 S.S., 20 HP mtr., automatic controls, many spare parts. Two yrs. service. Bargain for quick removal.

HORNE MACHINERY CO., INC.
1188 Harrison St. San Francisco 3, Cal.

CASH

FOR YOUR IDLE MACHINERY!

For top prices, quick action, contact us. Liquidations; appraisals our specialty.

Wire us your list today, or phone GA 1-1380

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. · San Francisco 7, Calif.

FOR SALE

PULVERIZERS & DRYER

4—Jeffrey Type B2, 24" x 20" Swing Hammer Pulverizers. Late Model. Good condition.

1—Single Shell Rotary Dryer, 31' long, 36" dia. Fully complete with Speed Reducer and Motor. Late Model.

DALTON SUPPLY CO. DALTON, PA.

COMPRESSORS

World's Best Rebuilts

27 CFM	3000 PSI Worth V4A3 & V4A3W
70 CFM	1500 PSI 9x8 Norwalk TDS3T
110 CFM	3000 PSI Ing. GC 50BW
138 CFM	100 PSI 7x7 Ing. Rand ES1
191 CFM	300 PSI 9-4½x9 Ing.
238 CFM	100 PSI 9x9 Ing. ES Worth HB
242 CFM	125 PSI 8x7 Joy WG9
311 CFM	1500 PSI 10½-7⅛-3½x13 IR-ES3
465 CFM	100 PSI 12x11-IR-ES-1-Worth HB
496 CFM	Vac. 14x7 CP-T (3)
502 CFM	125 PSI 12x13 Worth HB, IR-ES
676 CFM	100 PSI 15-9¼x12 Worth. & IR
686 CFM	100 PSI 14x13 Ing. ES
1545 CFM	110 PSI 21/13x14 IR XRE
3135 CFM	Vac. 31x13 Ing. ES
7950 CFM	200 PSI 33-17¾x27 Ing. PRE24C
60'-600' portable—gas or diesel	

AMERICAN AIR COMPRESSOR CORP.
North Bergen, N. J. UNion 5-4848

COMPRESSORS FOR SALE

FOUR 2000 H.P. STEAM-DRIVEN COMPRESSORS

Four (4) Skinner Clark #SCRA-6 steam-driven double-acting compressors (Condensing).

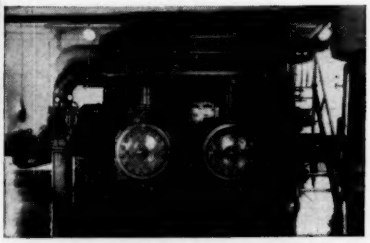
Each unit consists of six (6) Clark double-acting compressors with a total displacement of 6,360,000 cubic feet per 24 hours per unit. Each unit is built to the following specifications:

Bore.....14"	Class.....V.T.H.
Stroke.....14"	Maximum pressure. 400 pounds

Each unit is driven by a Skinner Universal Uniflow vertical condensing steam engine having the following specifications:

Bore.....18½"	R.P.M.....300
Stroke.....14"	Rated H.P.....2000

Each unit is equipped with complete condensing equipment. (These units can be seen operating.)



ONE 1500 H.P. STEAM-DRIVEN COMPRESSOR

One (1) Skinner Clark #SCRA-5 steam-driven double-acting compressor (Condensing).

Unit consists of five (5) Clark double-acting compressors with a total displacement of 8,320,000 cubic feet per 24-hour period. Unit is built to the following specifications:

Bore.....1-14", 2-21", and 2-27"	Class.....V.T.H. Maximum pressure.. 100, 160, 400 pounds
Stroke.....14"	

Unit is driven by a Skinner Universal Uniflow vertical condensing steam engine having the following specifications:

Bore.....18½"	R.P.M.....300
Stroke.....14"	Rated H.P.....1500

Unit is equipped with complete condensing equipment. (Can be seen operating.)

For further information write or call:

Mr. Charles L. Yost
THE PEOPLES NATURAL GAS COMPANY
Two Gateway Center
Pittsburgh 22, Pennsylvania
GRant 1-5100

Searchlight Equipment Locating Service

No Charge or Obligation

This service is aimed at helping you the reader of "SEARCHLIGHT" to locate Surplus new and used equipment not currently advertised. (This service is for USER-BUYERS only.)

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Searchlight Equipment Locating Service

Classified Advertising Division

Chemical Engineering

P. O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service
Classified Advertising Division
CHEMICAL ENGINEERING
P.O. Box 12, N. Y. 36, N. Y.

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STATE 7/27/59

***WANTED* SURPLUS EQUIPMENT**
SINGLE ITEMS OR ENTIRE PLANTS

FOR SALE

1—Baker Perkins 200 wc, cored dbl Sigma blades, jacketed, also internal pressure, Unidor type, size 17, DAM, very hvy duty.
1—75 gal Legion Kettle, all SS, Jacketed for 90 psi, 15 psi internal pressure, bottom outlet
1—Stokes Model R Tablet Press
2—Colton Model 5½ T Tablet Presses
1—Rotex Sifter, 21"x41"
3—Baker-Perkins 200 gal wo Mixers
1—Baker-Perkins 7 gal. wo Mixer
Stainless Steel Kettles 20 to 200 gal. in Stock

AARON EQUIPMENT CO. ALL PHONES GLadstone 1-1300
9370 Byron St., Schiller Park, Ill.

FOR SALE
2—80 HP Eclipse McKee "Supermatic" Horizontal Steam Generators

108 lbs. working pressure, Scotch type Series STCGO, Portable—mounted on steel skids, gas or oil fired with combination burner unit, complete with all controls, motors, and blower. Used less than one year. Can be used for low pressure by changing pop-off valve. MFG. IN 1952.

ESTES MACHINERY COMPANY
118 So. Clinton St. DEarborn 2-6595 Chicago 6, Ill.

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MOhawk 4-5800
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SUperior 1-7000
W. B. SULLIVAN—T. H. HUNTER

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FIRST CLASS EQUIPMENT from Your FIRST Source!

SPOTLIGHT SPECIALS

Baker Perkins Ko-Kneaders Continuous Type K 300 gal.

Baker Perkins Double Arm Jacketed Mixers to 300 gal.

Type 316 Stainless Reactors 1000, 2000 and 3500 gal.

Blaw Knox Conical Blender 300 cu. ft. 9'6" diam.

Simpson Muller Type Batch Blenders, Lab. to 6' size

Pfaudler 6' Diam. Evaporators in Stainless or Glass Lined

Mikro Pulverizers up to No. 4

Mikro S/S Atomizers, Nos. 5 & 6

Fitzpatrick Stainless Mills, Models D, K, and C, motorized

Pfaudler Glass Lined Reactors all sizes up to 1000 gal.

Mojonnier Stainless Vac. Pans Sizes 3' x 10' and 6' x 12'

Proctor & Schwartz Apron Type Dryers; 8' x 34½'; 5 sections

Double Drum Dryers to 40"x120"

Bowen 4' S/S Spray Dryer; compl.

Porcelain Lined Pebble Mills 36" x 42" to 8' x 8' complete

New Unused F-B Rubber Mills 14" x 30" with Uni-Drives

Send for "First Facts"

FIRST MACHINERY CORP.
209-289 TENTH STREET, BROOKLYN 15, N. Y.
PARKING ON THE PREMISES
PHONE: STerling 8-4672

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EIMCO 3' x 6' VAC. FILTER

Rubber, rotary, continuous Vacuum Filter. With Repulper.

PRICED TO SELL

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. · San Francisco 7, Calif.

—PIPE—

500,000 ft 10¾" 40#
250,000 ft 8⅝" 28½#
All machine cleaned, straight. Plain end, coated. Strickley No. 1. Pittsburgh Test. Lab. report furnished. Immediate delivery.

INDIANA-OHIO PIPE CO.
P. O. Box 323, Phone 34674, Decatur Ind.

STOCK ITEMS

CENTRIFUGALS, BASKET

1—48" A.T.&M. Susp., T304 SS perf.

6—40" A.T.&M. Susp., T304 SS Solid basket. 40 HP, 1952.

1—40" Bird, susp. steel, imperf.
1—36" Tolhurst, bronze center-slung.
2—30" A.T.&M. susp., T304 SS.
1—30" Fletcher, underdriven, T304 SS.
1—26" Fletcher, underdriven, T316 SS.
1—26" Tolhurst, susp., steel perf.

MILLS

2—Raymond #5057 hi-side
1—Kennedy 4' x 8' rod mill, 50 HP
4—A-C 5' x 22' ball mills, 150 HP
1—Traylor 8' x 11' ball mill, 300 HP
1—Penna. non-clog swing hammermill, 400 HP, UNUSED
1—Hardinge 4'6" x 16" conical ball mill, 25 HP
3—Jaw Crushers: 36" x 15", 20" x 6", 18" x 9"
3—Ink or Paint Mills, 3-roll: 9" x 24", 6" x 14"

ROTARY KILNS—DRYERS

1—11' x 155' Traylor, ⅞" shell Kiln.
1—9' x 100' Vulcan, ⅝" shell Kiln.
1—8' x 115' ⅝" shell, 2-tire Kiln.
2—7'6" x 100' ½" shell Kilns.
1—7'6" x 65' Kiln, ½" shell.
2—6' x 60' ⅝" shell Kilns.
1—4' x 24', 2-tire Kiln.
4—Hardinge 8'8" x 7' Dbl. shell dryers, #XA-18, welded, ½" shell.
1—7'6" x 65' dryer, ½" welded shell.
1—Allis-Chalmers 7' x 50' dryer.
1—6' x 50' Louisville dryer.
6—Steel dryers: 5'6" x 50', 4'9" x 32', 4'6" x 40', 4'6" x 32', 4' x 30', 3' x 15', 2—Stainless dryers: 4'6" x 12', 3' x 10'.

TANKS

1—8000 gal. T304 SS, vert.
12—4500 gal. nickel-clad, vert. 125#.
1—3000 gal. alum., vert., open.
1—10,500 gal., T 304 SS, horiz., UNUSED, dished heads.
2—5700 gal., T304 SS, horiz., UNUSED.
4—Vacuum tanks w/coils, T304 SS: 3700, 3000, 2350, 1750 gal.
1—3400 gal., T304 SS, horiz.
1—2000 gal., T316 SS, hopper.
8—1750 gal., T304 SS, hoppers.
1—1400 gal., T316 SS, ASME, 175#.

10—BAKER-PERKINS SIZE #17 Double Sigma blade mixers, jacketed, screw or hydraulic tilts, motors, drives, etc. *LOWEST PRICES EVER!*

3 MILLION DOLLAR LIQUIDATION

Type 316 Stainless Steel Equipment

CHEMICAL PLANT—ORANGE, TEXAS

TYPE 316 STAINLESS STEEL TANKS

1—17,650 gal. 9' dia. x 36' long, T316 SS, ¼" shell, ⅜" heads w/coil.
2—6,500 gal. 11' dia. x 7' high, T316 SS, 7/16" shell, ½" heads.
12—2,300 gal. 7' dia. x 8' high, T316 SS, ¼" shell, coils (some with agitator).
2—2,000 gal. 6'6" O.D. x 8' long, ¼" shell.
2—1,100 gal. 5'6" dia. x 6' high, T316 SS, w/coils, with agitator.
4—1,200 gal. 5' dia. x 7' high, dished top, 42" deep conical bottom (crystallizer tanks).
7—560 gal. 3'6" dia. x 7' high, ¼" dished top, 4' deep conical bottom.
55—Tanks and Pots from 10 gal. to 350 gal. sizes, vertical and horizontal, dished heads.

STAINLESS STEEL COLUMNS

1—108" Dia. Vulcan scrubber, 10 trays on 12" centers, 252—bubble caps per tray.
1—96" dia. x 13' high scrubber, 10 stainless steel trays on 12" centers, 276—caps.
2—96" dia. x 35' high bubble cap columns, 30 trays, 12" spacing, 272—caps per tray.
2—60" dia. x 13' high, Vulcan scrubbers, ¼" shell, 10 trays, 100—caps per tray.
1—48" dia. column, 25 trays, bubble caps, T304-ELC.
3—30" dia. packed columns, 25' high, T316 SS.
4—24" dia. bubble cap columns, 12 trays, T316 SS, 18" spacing—Vacuum.
2—20" dia. stainless steel columns, 25' & 30' high.

COPPER COLUMNS

1—72" dia. Vulcan bubble cap copper column, 46'10" high, 40—trays.—Vacuum.
2—48" dia. bubble cap copper columns, 25 & 40 trays, 31' & 45' high.—Vacuum.
2—42" dia. Vulcan stills, 56" high. (Evaporator bodys).
1—24" dia. column, 25'8½" long, 20 trays, bubble caps.

FILTERS—CRYSTALLIZERS

2—Sharples C-20 Super-D-Hydrators T316 SS.
3—18,000 gal. Aluminum Cone bottom tanks, 12' dia. x 31' O.A.H.
4—1200 gallon Crystallizers, T316 SS, 5' dia. x 7' high, dished top, conical bottom.
7—560 gal. Crystallizers, T316 SS, 3'6" dia. x 7" high, dished top, conical bottom.
3—Worthington 160 Ton steam jet refrigeration units.
1—Pneumatic Conveyor System, approx. 1150' 10" dia. Aluminum Pipe.

TYPE 316 STAINLESS STEEL KETTLES

3—3,500 gal. jacketed kettles, 7' dia. x 12' high, T316 SS. 11/32" shell, dished heads, 11 turns SS coil, two-speed agitator, 40/20 HP-1750/500 RPM.
1—2,500 gal. 6' dia. x 12' high, T316 SS, horiz. still kettle.
3—1,000 gal. 5'6" dia. x 6' high, T316 SS, int. coils, turbine agit.

CONDENSERS—HEAT EXCHANGERS—CALANDRIAS—COOLERS

1—1,450 sq. ft. condenser, stainless steel tubes, tube sheets, heads, and baffles.
1—1,200 sq. ft. condenser, stainless steel tube, steel shell.
14—750 & 800 sq. ft. stainless steel condensers, vertical, T316 SS tubes and heads.
9—Condensers, 356, 400, 410, and 550 sq. ft., T316 SS.
5—Calandrias, 140, 145, 150, 157, 250, 277 sq. ft., T316 SS.
11—Exchangers, 64, 70, 75, 80, 100 sq. ft., T316 SS.
12—Exchangers 20, 30, 47, 50 52, 54 sq. ft., T316 SS.
15—Cupro-Nickel & Copper exchangers, up to 1070 sq. ft.

MISCELLANEOUS EQUIPMENT

10,000—T316 SS pipe & tubing, 1", 2", 3", etc. up to 12".
2,000—Valves, T316 SS, up to 12".
1—Otis elec. freight elevator, 5000# @ 75 FPM.
40—Stainless steel pumps 1" to 6", 1 HP to 20 HP.
3—Steel columns: 48", 30", 20" dia.
2—St. St. bucket elevators, 62' and 45' high.
4—Stainless steel screw conveyors and chutes.
1—2,000 gal. aluminum tank, 6' dia. x 10' high, coils.
25—Stainless steel steam jet evactors and ejectors.
18—Separators, T316 SS, 22" x 8' overall depth, cone type.
1—Croll-Reynolds #21 jet vacuum air pump, capacity 50# per hour.

SEND FOR CIRCULAR

PERRY EQUIPMENT CORPORATION

1413-21 N. SIXTH ST. PHILADELPHIA 22, PA.

Phone POplar 3-3505

WHY DREAM—OBEY THAT IMPULSE—
BUY
GELB
CHEMICAL PROCESS EQUIPMENT NOW!

2—Pfaudler 500 gal, glass lined, jacketed reactor, complete with anchor type agitators and drives.
1—Tolhurst type 316 S.S. 40" suspended type centrifuge complete with perforated basket, plow and motor.
1—Tolhurst type 347 S.S. 40" suspended type centrifuge complete with perforated basket, plow and motor.
1—Buflovak chrome plated vacuum double drum dryer, 32" x 72" complete.

AUTOCLAVES, KETTLES AND REACTORS

2—Steel & Alloy Tank Co. 100 gal. type 347 S. S. pressure tanks, 250# pressure..
1—Steel & Alloy 350 gal. type 347 S.S. pressure tank, 250# pressure.
1—Steel & Alloy 125 gal. type 347 S.S. jacketed autoclave, 250# internal and jacket pressure.
1—Blaw-Knox 400 gal. steel jacketed autoclave, 570# internal pressure, 85# jacket.
1—Columbia Engineering high pressure storage tank, 2400 gal. 265# working pressure.
2—Struthers Wells type 316 S.S. jacketed reactors, 3500 gal. complete w/coils, agitators & drives.
1—Pfaudler 750 gal. glass lined storage tank.

DRYERS

1—Link Belt steel roto louvre dryer, model 1003-30
4—Link Belt steel roto louvre dryers, Model 207-10, 310-16, 310-20, 604-20
1—Buflovak double drum dryer, 42" x 120"
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
1—Stokes double drum dryer, 5' x 12'
1—Louisville rotary steam tube dryer, 8' x 45'
1—Louisville S.S. rotary kiln, 30" x 28" complete
1—Louisville rotary dryer, 38" x 40', type L.
3—Louisville S.S. rotary dryers, 8' x 50'
1—Ruggles Coles 4' x 30" rotary kiln
1—Traylor 4' x 40' rotary dryer
1—Swenson 10" dia. Spray dryer
2—Rotary dryers, 6' x 36'

FILTERS

3—Dorco 6' x 2' rubber covered filters
1—Sweetland #3 S.S. filter
1—Niagara S.S. Filter, Model 510-28
1—Oliver horizontal filter, 3'
1—Feinc S.S. rotary vacuum string filter, 3' x 3' (New)
10—Shriver plate and frame filter presses, 12" to 42"
12—Sweetland #12 filters with 72 S.S. leaves
1—Shriver rubber lined filter press, 36" x 36"
2—Niagara S.S. filters Model 36H-110-3

MIXERS

1—Patterson jacketed vacuum S.S. sigma blade mixer, 300 gal.
1—Readco S.S. jacketed vacuum sigma blade double arm mixer, 25 gal.
3—Robinson type 316 S.S. sigma type jacketed heavy duty mixers, 400 gal.

THE GELB GIRL—JULY 1959

5—Baker Perkins doubled arms blade mixer, 100 gal.
1—Patterson monel double cone blender, 4 cu. ft.
19—Robinson S.S. horizontal blenders, 255 cu. ft.
1—12" x 4' type 316 S.S. Pug Mixer
1—Munson Rotary Blender, 40 cu. ft.

MISCELLANEOUS

1—Ames 300 HP steam generator, 150#
1—Cleaver Brooks 500 HP package steam generator, 200#
2—Heat Transfer Products steel bubble cap columns, 36" x 42" with 5 and 10 trays
1—Acme steel bubble cap column, 42" dia. with 10 trays
2—Patterson-Kelley steel heat exchangers, 1000 sq. ft. each
6—Struthers Wells heat exchangers, 885 sq. ft.
1—Patterson-Kelley steel heat exchanger, 427 sq. ft.
50—Steel heat exchangers from 15 sq. ft. to 400 sq. ft.
1—Struthers Wells type 316 S.S. heat exchanger, 330 sq. ft.
10—Davis Engineering type 316 S.S. heat exchangers, 85 sq. ft. to 170 sq. ft. (NEW)
1—Badger type 316 S.S. bubble cap column, 42" dia. with 11 trays
1—Badger type 316 S.S. bubble cap column, 36" dia. with 8 trays
1—Vulcan S.S. bubble cap column, 4' x 28 plates
3—Robins shaker screens, S.S. 3' x 6'
1—Stokes Model DDS2 Rotary tablet press
1—Struthers Wells S.S. calandria type evaporator, 365 sq. ft.
1—Swenson type 316 S.S. vacuum crystallizer, 3'6" x 12'
1—Swenson type 316 S.S. vacuum crystallizer, 2' x 12'
1—Swenson single effect evaporator, S.S. 320 sq. ft.
1—Blaw-Knox steel distillation column, 36" x 40' with 24 trays, complete (NEW)
3—Williams type 316 S.S. hammermills, Model AK
1—Mikro Model 4th pulverizer
7—Milton Roy proportionating pumps, S.S. 1½ GPH to 156 GPH

2—Tolhurst 40" suspended type, rubber covered centrifuge, complete with perforated baskets, plow and motor.
4—Tolhurst 30" center slung rubber covered centrifuges, with perforated baskets.
2—Sturtevant #7 dustless type 304 S. S. batch blenders, New.
1—Steel & Alloy, 200 gal. type 347 S.S. jacketed autoclave, 250# jacket and internal pressure.

Established 1886

R. GELB & SONS, Inc.,

CHEMICAL, RUBBER, OIL, PLASTIC and FOOD PROCESSING MACHINERY

U.S. HIGHWAY No. 22, UNION, N.J. • MUrdock 6-4900

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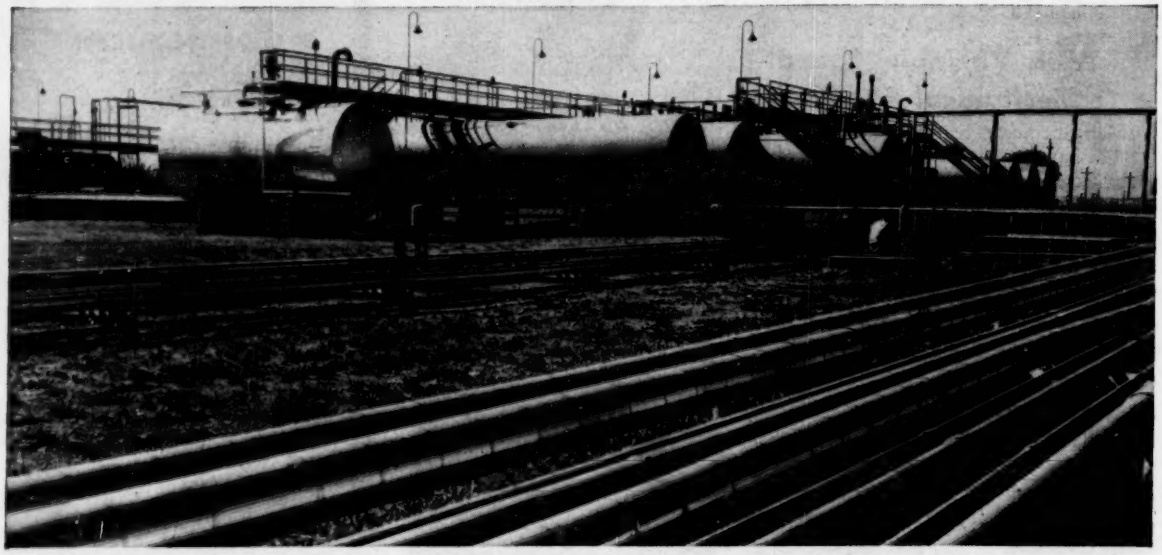
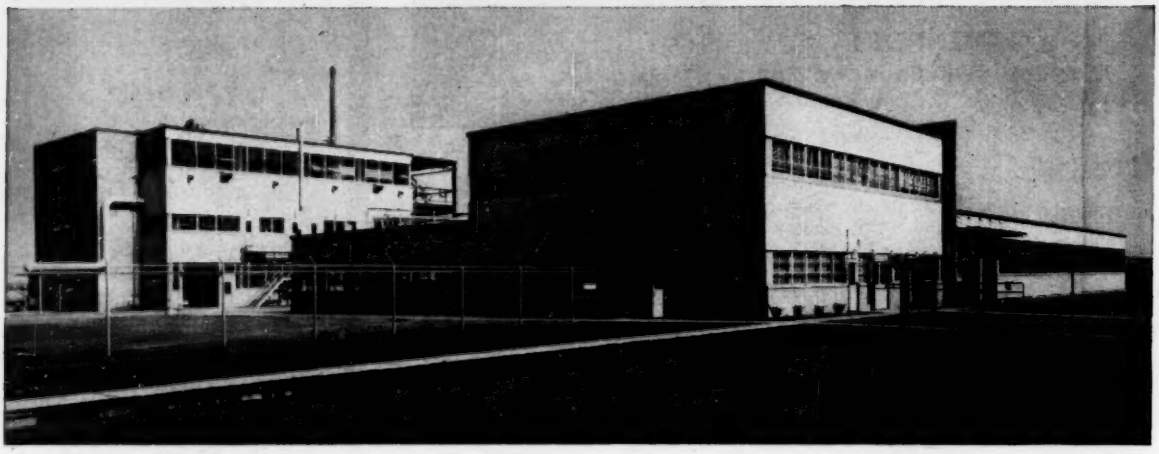
ADVERTISERS

Blaw-Knox builds complete Henry, Illinois, plant including all auxiliary facilities for B. F. Goodrich Chemical Company. Extensive tank farm includes raw material, finished product, and fuel storage. Main units shown below include process building (at left) office and warehouse units (at right).





B. F. Goodrich Chemical builds new $5 million organic chemical plant

This new plant, built by Blaw-Knox, enables B. F. Goodrich Chemical to supply the oil, rubber, and plastics industries with a new series of antioxidants and other specialty chemicals.

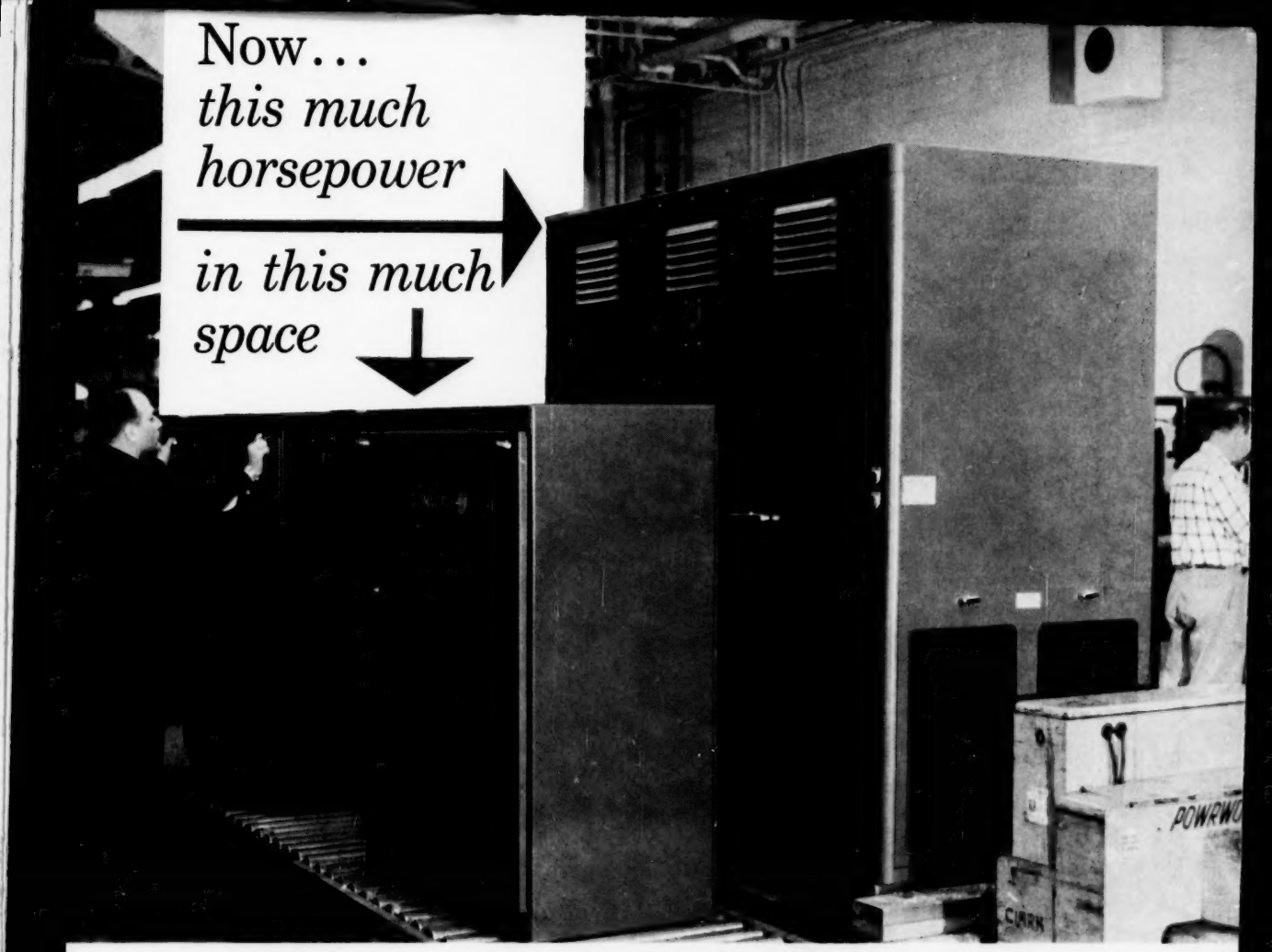
In addition to the process areas on this complete-from-grass-roots project, Blaw-Knox's contribution included design, construction, and installation of the plant's auxiliary facilities. Utilities—including the water supply, waste disposal, and fire protection systems—were designed to handle about four times the plant's initial capacity. The tank farm with its extensive and complex piping system also was built to accommodate future increased output.

Throughout the entire project Blaw-Knox teamed closely with B. F. Goodrich to design a plant with a built-in future in meeting the increasing demand for rubber chemicals.

Contact Blaw-Knox Chemical Plants Division for a preliminary discussion on your next project. Headquarters in Pittsburgh; branch offices in New York; Haddon Heights, N.J.; Washington, D.C.; Birmingham; Chicago; and San Francisco.

BLAW-KNOX

plant builders for industry...



New 50 hp. Super "T" V★S Control Units compared with 50 hp. old style drive on Reliance production line.

New Reliance SUPER 'T' V★S DRIVES put more power into a 35% smaller package

You can increase usable work space and improve machine performance with the New Reliance Super 'T' V★S Drive. More than just a compact drive, the Super 'T' packs extra punch into its new small size.

Like the Super 'T' Drive Motor, the new control unit uses Class B insulation, and will take repeated 100% overloads of one minute duration. These features plus special control apparatus design and the Super 'T' D-c. Drive Motor actually put more power in less space.

This systematic design balance of power unit, drive motor and controls forms a fast functioning drive to provide a wide range of variable operating speeds from a-c. circuits.

40—150 hp. Super 'T' V★S available for immediate delivery. Contact your Reliance Sales Engineer for delivery schedules of the complete line, 1—350 hp.

C-1624

Product of the Reliance Electric and Engineering Company, manufacturers of a-c. motors, Master Gearmotors, Reeves Drives, Super 'T' D-c. Motors, generators, controls and engineered drive systems.

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 137A1, CLEVELAND 17, OHIO

Canadian Division: Toronto, Ontario

Sales Offices and Distributors in principal cities

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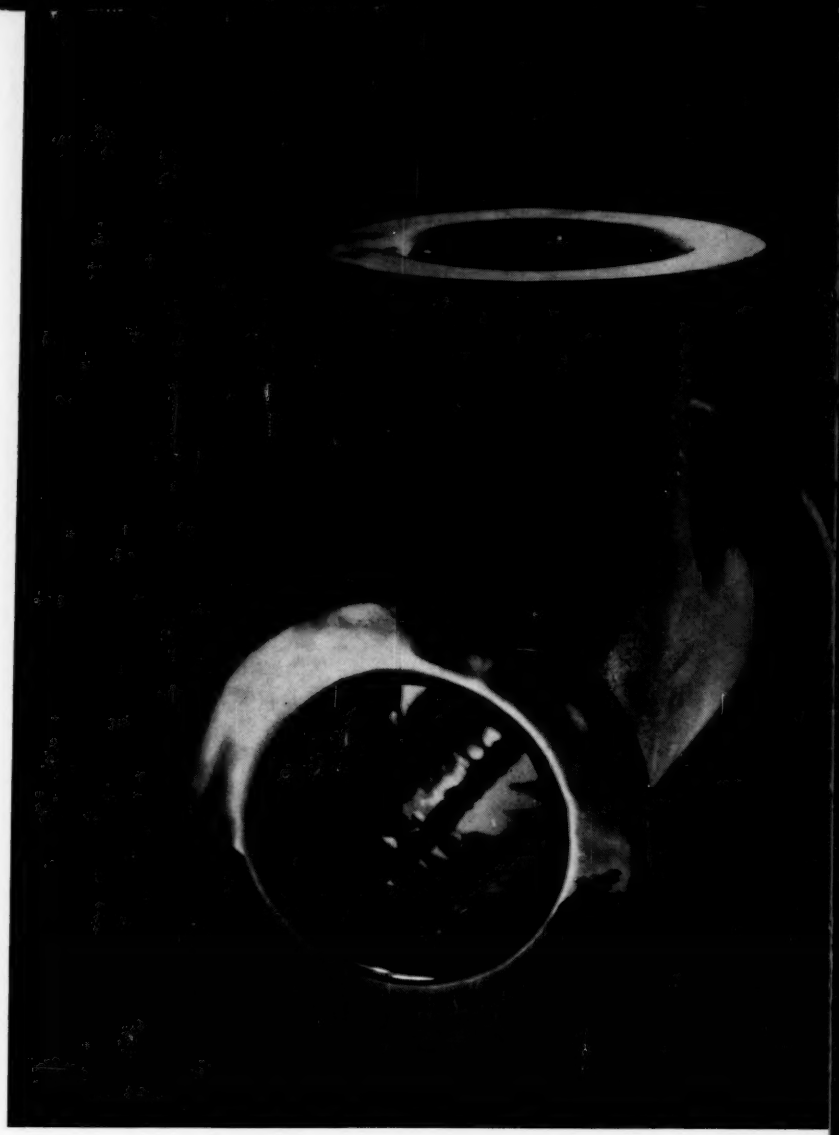

FLUIDICS

is a Pfaudler Permutit program
providing the know-how
the equipment
and the experience
for solving problems
involving fluids

FLUIDICS covers:

corrosioneering	**blending**
water treatment	**metering**
waste treatment	**valving**
reactions	**piping**
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evaporation	**agitation**
distillation	**heat transfer**

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Now in stock

Glassed "ductile iron" fittings* with strength comparable to Glasteel's

Now you can specify glassed-metal fittings with the same confidence buyers have in Glasteel equipment.

New to the Pfaudler line is a series of glassed *ductile iron* fittings exhibiting physical and chemical properties similar to Glasteel 59's.

High strength: 60,000 tensile, 45,000 yield and 15% elongation per ASTM-A-395-56T. Other types available on request. Ductile iron, after glassing, is 2½ to 3 times stronger than low-strength gray iron.

Improved thermal shock resistance: Far superior to glassed gray iron—now comparable to the thermal shock resistance of Glasteel 59.

Excellent corrosion resistance: Resistant to all acids (except hydrofluoric) even at elevated temperatures and pressures, and to most alkaline solutions at moderate temperatures.

Acceptance: Because of its superior strength, ductile iron No. 60-45-15 is widely used in the petroleum industry.

If you've wanted the corrosion resistance and strength of glassed metal but have ruled out gray iron fittings, you'll want to inquire about glassed "ductile iron" fittings from Pfaudler. Write to our Pfaudler Division, Dept. CEB-79, Rochester 3, N. Y.

*Pat. Pending

Pfaudler Permutit is observing its 75th anniversary. The company has manufacturing plants in Germany (Pfaudler-Werke A.G.), Great Britain (Enamelled Metal Products Corp. Ltd.), Canada (Ideal Welding Co. Ltd.), Mexico (Arteacero-Pfaudler, S.A.), and Japan (Shinko-Pfaudler Co., Ltd.), and four plants in the U.S. Sales offices and representatives in leading cities throughout the free world.

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